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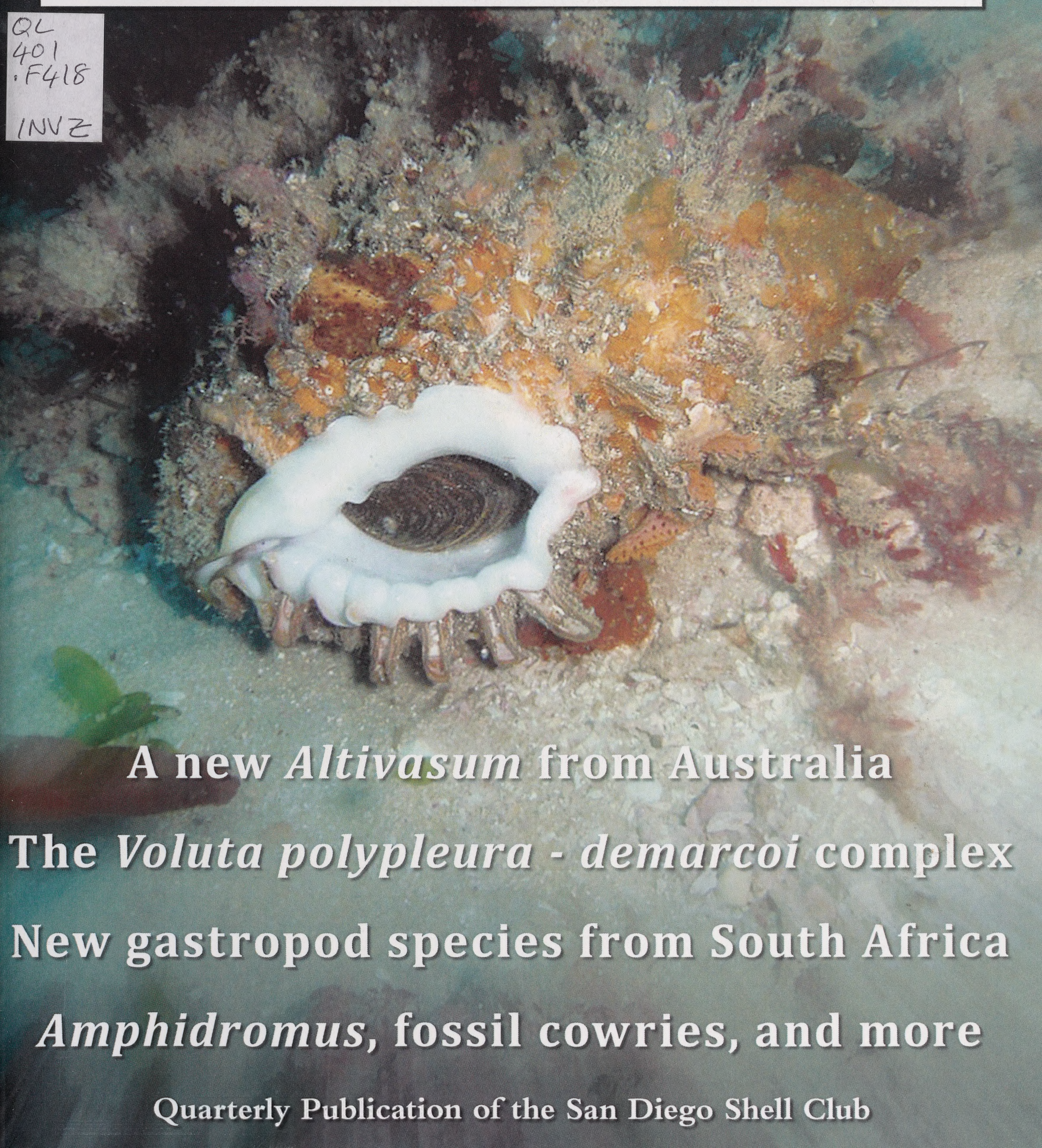

A new *Altivasum* from Australia

The *Voluta polypleura - demarcoi* complex

New gastropod species from South Africa

Amphidromus, fossil cowries, and more

Quarterly Publication of the San Diego Shell Club

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THE FESTIVUS

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Volume: 51 August 2019 ISSUE 3

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Under water photo of a live *Alivasum flindersi* Verco, 1914, taken by the late Peter Clarkson. Photo used with permission. All rights reserved. (Cover artistic credit: Rex Stilwill).

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Holiday party - December 14, 2019

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Volume: 51 August 2019 ISSUE 3

TABLE OF CONTENTS

Peer Reviewed Articles

- A new name for *Altivasum typicum* Hedley, 1916 fide Dekkers and Maxwell, 2018 and the description of *Altivasum clarksoni* n. sp. 171
  By Stephen J. Maxwell and Aart M. Dekkers
- A new species of *Amphidromus* Albers, 1850 from Krong Pac District, Dak Lak, Province in the Central Highlands, Vietnam 177
  By Jeff Parsons
- A review of the *Voluta polypleura - demarcoi* complex 184
  By David P. Berschauer
- Five New Gastropoda (*Casmaria*, *Sassia*, *Kilburnia*, *Quasimitra* and *Calliostoma*) from the Eastern Seaboard of Southern Africa and a Revision of *Mitra boswellae* 198
  By Roy Aikens and Allan Seccombe
- New Species of Mollusks (Gastropoda and Bivalvia) from the Tropical Western Atlantic, West Africa, and Red Sea 218
  By Edward J. Petuch and David P. Berschauer
- Two new subspecies of *Amphidromus* from Indonesia (Mollusca: Gastropoda: Camaenidae) 231
  By Nguyen Ngoc Thach
- The Fossil Cypraeidae of the Golden Gate Member, Tamiami Formation of of Southern Florida: (Mollusca: Gastropoda: Cypraeidae) 237
  By John D. "Duffy" Daughenbaugh

Club News 246

Articles of General Interest

- Beachcombing in Imperial Beach 247
  By David B. Waller
- San Diego County Fair 256
  By Lisa Dawn Lindahl

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Volume: 51 THE FESTIVUS ISSUE 3

A new name for *Altivasum typicum* Hedley, 1916 fide Dekkers and Maxwell, 2018 and the description of *Altivasum clarksoni n. sp.*

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ABSTRACT This paper addresses the taxonomy irregularity concerning *Altivasum typicum* Hedley, 1916 fide Dekkers and Maxwell, 2018 that has historically been synonymized under *Altivasum flindersi* Verco, 1914. We introduce the erection of *Altivasum hedleyi* n. sp. correcting this taxonomical conundrum that originated from the Hedley (1916) paper. Furthermore, this paper presents a new morph of *Altivasum* restricted to Esperance in Western Australia. *Altivasum clarksoni* n. sp. morphologically differs from *Altivasum flindersi* Verco, 1914 having solid pyramidal knobs on an acute shoulder and a form that is much more equi-biconic. *Altivasum hedleyi* n. sp. is also sympatric in part with *Altivasum clarksoni* n. sp. but is much smaller and the early teleoconch differs in structural form. This paper brings the number of described *Altivasum* and their forms to four.

KEY WORDS *Altivasum*, *A. hedleyi*, *A. clarksoni*, Vasinae, Australia, morphology, taxonomy

INTRODUCTION

Dekkers and Maxwell (2018) reviewed the genus *Altivasum* Hedley, 1914 and recognized three taxa in what was once considered a monotypic genus after Abbott (1959). One possible explanation for the over synonymization that occurred under Abbott (1959) was a possible ridged adherence to a biological species conception and the reflection of this in a cline driven taxonomy. The process of unraveling the taxonomy of *Altivasum* Hedley, 1914 *ex* Abbott, 1959 is an ongoing one, particularly as more material becomes available. One of the major draw backs in the stabilizing of *Altivasum* Hedley, 1914 taxonomy is the lack of material with sufficient data to map distributions and morphology. The known range limits of *Altivasum* are not fixed and as more material becomes available, the overlap between the three existing taxa without significant morphological integration is becoming more evident. This overlap and species morphological stability justifies the rank of species rather than subspecies for these taxa.

This paper presents a new *Altivasum* species, which provides another evolutionary reference point within the nomenclature to assist in gaining an understanding of the radiation and distribution patterns within the complex. Furthermore, this paper presents a rejection of the Dekkers and Maxwell (2018) taxonomic conservancy with the acceptance of *Altivasum typicum* Hedley, 1916, which was grounded in the Hedley (1916) description being sound in construction and the availability of the name *"typicum"*. However, we identify two problems with this use of *"typicum"* for this taxon: first is that it is an objective junior synonym of *Altivasum flindersi* Verco, 1914; and, second with the underlying intent of Hedley (1916) when presenting *"typicum."* Additionally, a dwarf sympatric taxon, *Altivasum clarksoni* n.

sp. is identified, from Sandy Hook Island, Esperance, Australia.

SYSTEMATICS

Superfamily: Turbinelloidea Rafinesque, 1815
Family: Turbinellidae Swainson, 1835
Subfamily: Vasinae Adams and Adams, 1853
Altivasum Hedley, 1914
Type species: *Latirus aurantiacus* Verco, 1895 (= *Altivasum flindersi* Verco, 1914).
Synonymy.
Altivasum Hedley, 1914, p. 68. Dekkers and Maxwell 2018, p. 246.
= *Vasum* (*Altivasum*) Hedley - Wenz 1946, p. 1300. Abbott 1950, p. 213. Abbott 1959, p. 25. Wilson 1994, p. 60.

Altivasum hedleyi Maxwell & Dekkers,
new species (Figure 3A)

Synonymy.
Altivasum typicum Hedley, 1916, p. 207. Dekkers and Maxwell 2018, p. 249, figs. 2b, 4, 6b.
Altivasum aurantiacum Verco - Hedley 1914, p. 69, pl. 9, fig. 2.
Altivasum flindersi Verco - Hinton 1972, p. 46, fig. 1. Wilson and Gillet 1972, p. 112, pl. 7 fig. 3. Wells and Bryce 1986, p. 11, fig. 436.
Vasum flindersi Verco - Wilson 1994, p. 60, pl. 8, figs. 12a and b.
Dekkers & Maxwell (2018: 249, figs. 2b, 4, 6b) erroneously considered this new species to be *Altivasum typicum* Hedley, 1916. The name *Altivasum typicum* Hedley, 1916 is unavailable as it is an objective synonym for *Altivasum aurantiacum* Verco, 1885 (= *Altivasum flindersi* Verco, 1914).

Type material. Holotype: Hedley (1914), pl. 9, fig. 2.

Type locality. Great Australian Bight between Long. 126° and 129°, 220 metres (crabbed).

Etymology. Named in honour of Charles Hedley (1862-1926) whose early work on Australian Mollusca was ground breaking.

Altivasum clarksoni Maxwell & Dekkers,
new species (Figures 1 and 2)

Description/Diagnosis. Shell similar in form to *Altivasum hedleyi* n. sp. but is greatly diminished in size. The shell is finely sculptured with scales. The spire possesses broad flat axial ribs that become acute with later whorls at the shoulder. The body whorl has large broad flat raised axial ribs that shoulder with distinctive solid acute pyramidal knobs but never develop into long hollow spines. The anterior of the body whorl has strong concave enlarged scales that form hollow short spines. The shoulder of the teleoconch is somewhat angulate. All whorls show strong axial cording. The shape is near equi-biconic.

Type material. The holotype is held in the West Australian Museum No. 69372 (Figure 1). The specimen was donated by Trevor and Marguerite Young, of Cannonvale, Queensland. A total of four other syntypes of the new taxon were also acquired from the Clarkson Collection (Figure 2).

Type locality. SSE side of Sandy Hook Island, off Esperance, Western Australia. Diver at 30 m, 2010. All known specimens are from this location and collected on the same date.

Etymology. Named in honour of Peter Clarkson, on the recommendation of collection Trevor and Marguerite Young, of Cannonvale, Queensland who donated the specimen to the West Australian Museum. Although we did not experience it ourselves, Peter's enthusiasm and drive to explore new habitats for seashells made him inspirational to all shell collectors. He is remembered fondly by many for his enthusiasm, generosity and friendship which touched many lives [see Peter Clarkson memorial page http://www.facebook/groups/324024881799666]

DISCUSSION

This revision brings the total number of described *Altivasum* Hedley, 1914 to four (see Figure 3). *Altivasum clarksoni* n. sp. provides a new taxonomic reference point on which to develop a greater understanding of the *Altivasum* Hedley, 1914 complex. In relation to *Altivasum hedleyi* n. sp., the authors demonstrate that revision of any complex involves the re-examination and reconsideration of information as it comes to hand. In the case of *Altivasum* Hedley, 1914, all species have more or less defined ranges, and morphological differences. *Altivasum hedleyi* n. sp. and its forms can be readily distinguished by the subsutural fimbrilations, which is in contrast to *Altivasum profundum* Dekkers and Maxwell, 2018, where the subsutural fimbrilations are lacking.

Altivasum clarksoni n. sp. is a small species reaching a maximum size of 65 mm. This is in contrast to the sympatric *Altivasum hedleyi* n. sp. which is known to reach over 200 mm. While the soft parts of the animal have not been examined, there are no recorded examples of sexual dimorphism in Vasinae Adams and Adams, 1853 that would equate to a large size discrepancy nor such significant changes in morphological form between the two taxa (Abbott 1959). We do not believe that *Altivasum clarksoni* n. sp is a male form of *Altivasum hedleyi* n. sp.

The choice of species rank over form or subspecies for this taxon reflects a more nuanced understanding of the role of infra-specific ordering. We consider forms to reflect a consistent variant within a wider population. The new species is not a form, *Altivasum clarksoni* n. sp. represents both the consistency in size and form, and names a localized variant. Páll-Gergely *et al.* (2019) argued that the rank of subspecies was arbitrarily applied based on “human factors.” These factors reflect the choices that the taxonomist has to make with regard to the differentiating of taxa in terms of morphology, homology and the pre-existing taxonomic hypotheses (Páll-Gergely *et al.* 2019). However, Páll-Gergely *et al.* (2019) offer no practical solution to how subspecies should be identified; rather they are seeking a rule to “prohibit taxonomic decisions resulting in uneven subspecies rates across taxonomic groups.” This raises the serious question of what is a “subspecies,” and in particular once you move away from the biological species concept how do you demarcate between subspecies and what is considered a full species. We argue that subspecies should be restricted to cryptic species, where the difference between taxa are grounded on the unobservable genetic distance; there is no morphological difference and typically no test for biological isolation between isolated populations or their clines. That is, we argue that the rank of subspecies should be applied to reflect genetic differences within a species complex, rather than used to distinguish unique taxonomic entities with observable differences. These are species. Subspecies therefore, is a rank that should be restricted to cryptic species. This approach would provide a level of taxonomic stability to the species rank and at the same time address the issues identified in Páll-Gergely *et al.* (2019). Where a taxon can be readily identified based on observable differences we argue, as the case of the species herein, that the rank of species is justified.

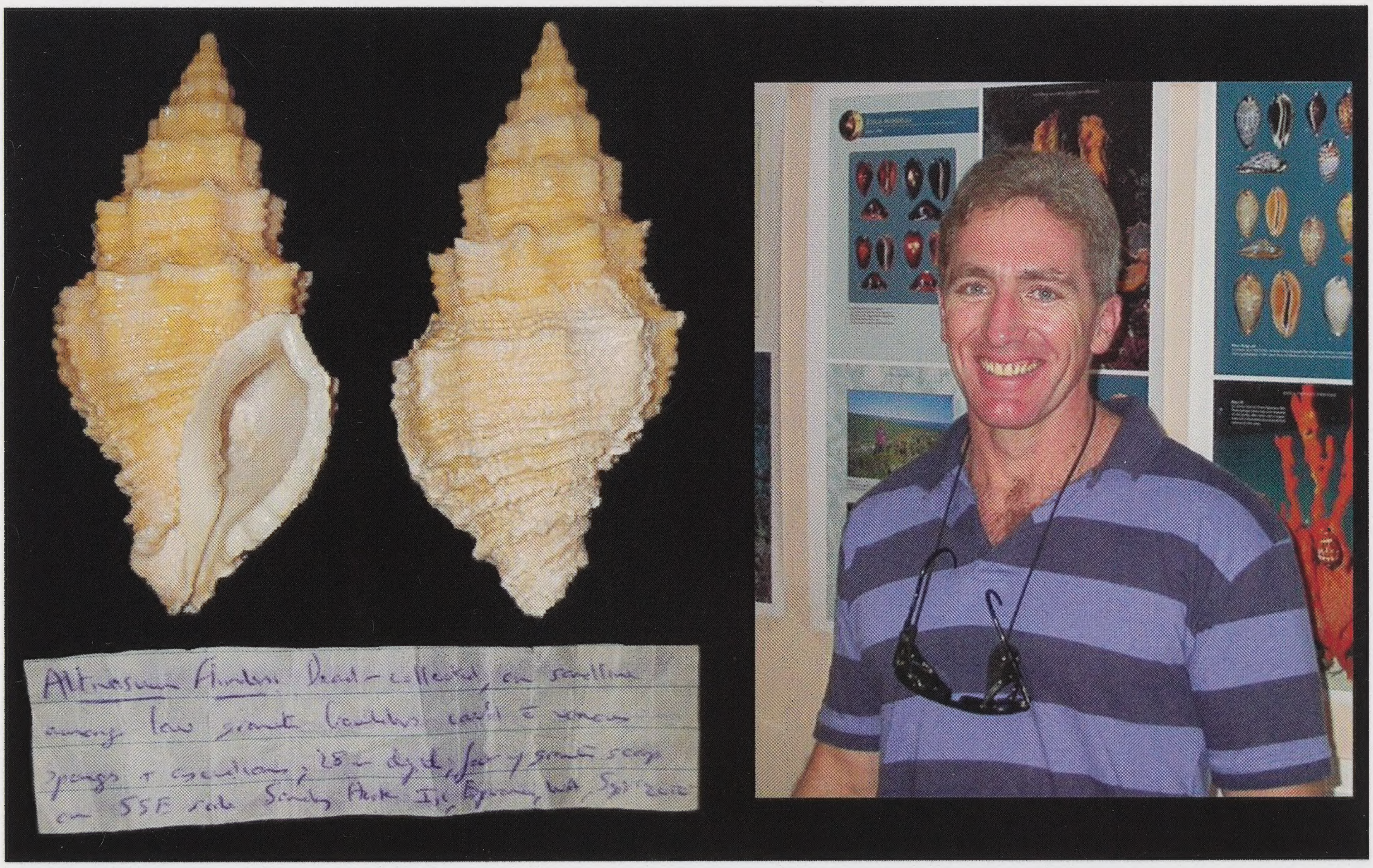
Altivasum flindersi Dead-collected, on sandline
among low granite boulders cov'd c various
sponges + ascidians, 28m dpth, foot of granite scarp
on SSE side Sandy Hook Is, Esperance, WA, Sept 2010

Figure 1. They holotype of *Altivasum clarksoni* n. sp. (West Australian Museum No. 69372) Sandy Hook Island, Esperance, Western Australia, with original label, and a photograph of Peter Clarkson after whom the shell is named (Collection of Trevor and Marguerite Young, height Syntype 2: 65 mm; Image – http://www.facebook /groups/324024881799666 accessed 03/06/2019). The original Clarkson label reads: "*Altivasum flindersi*, dead collected on sand line among low granite boulders covered with various sponges and ascidians, 28 m depth, foot of granite scarp. On SSE side of Sandy Hook Island, Esperance, West Australia, September 2010".

ACKNOWLEDGMENTS

The authors thank Philippe Bouchet MNHN and Henk Dekker, Winkel, the Netherlands, for highlighting the taxonomic problems with the use of "*typicum.*" We thank Henk Dekker for critically reading of the manuscript. The authors also thank Trevor and Marguerite Young, of Cannonvale and Anne Butler, Brisbane for proof reading the manuscript.

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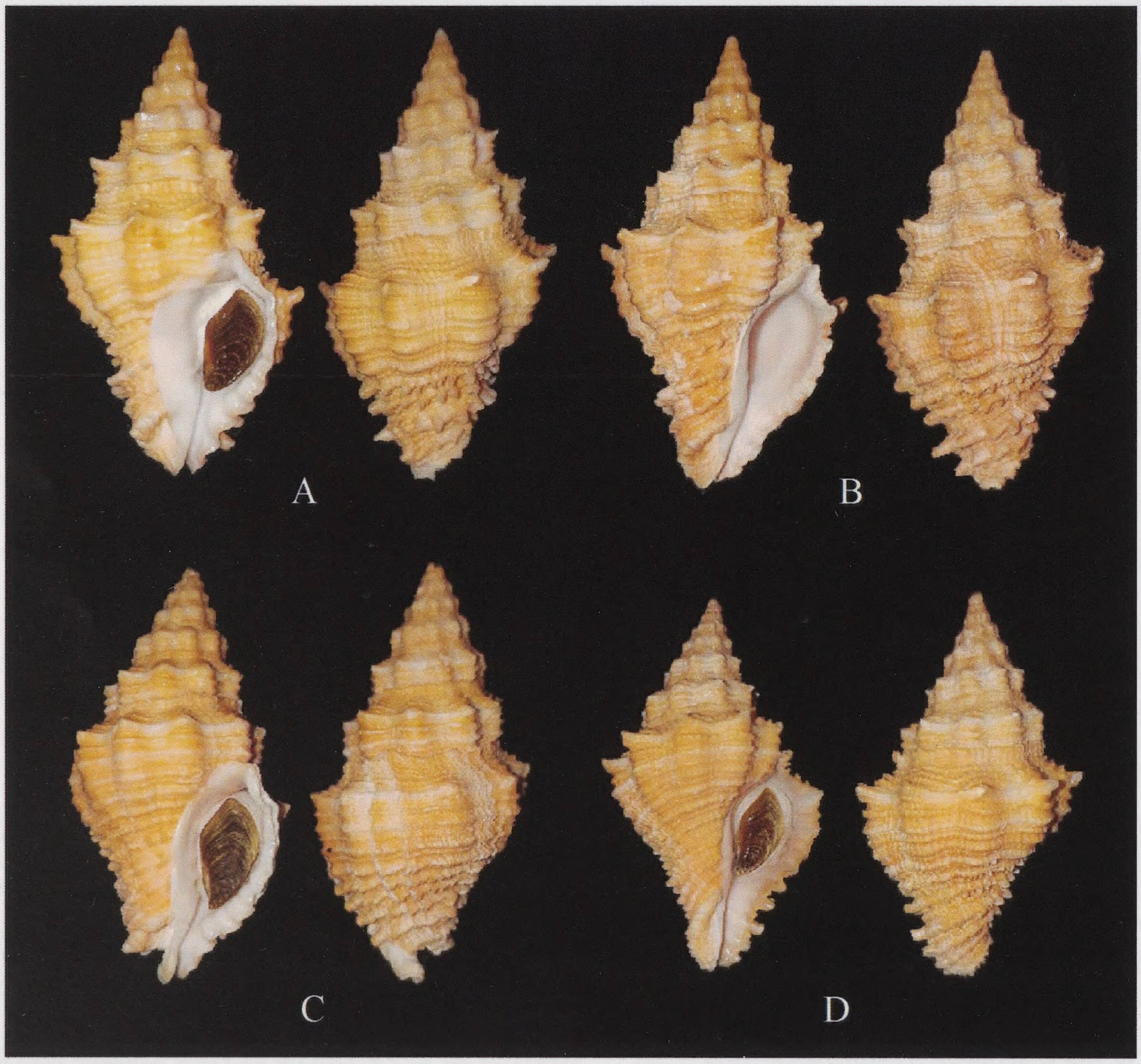

Figure 2. The paratype set for *Altivasum clarksoni* n. sp. (All Sandy Hook Island, Esperance, Western Australia): **A** = paratype 1: collection of Trevor and Marguerite Young, height 62.0 mm; **B** = paratype 2: collection of Trevor and Marguerite Young, height 63.5 mm; **C** = paratype 3: collection of Aart M. Dekkers, height 55.6 mm; and **D** = paratype 4: collection of Stephen Maxwell, height 48.0 mm (sub-adult).

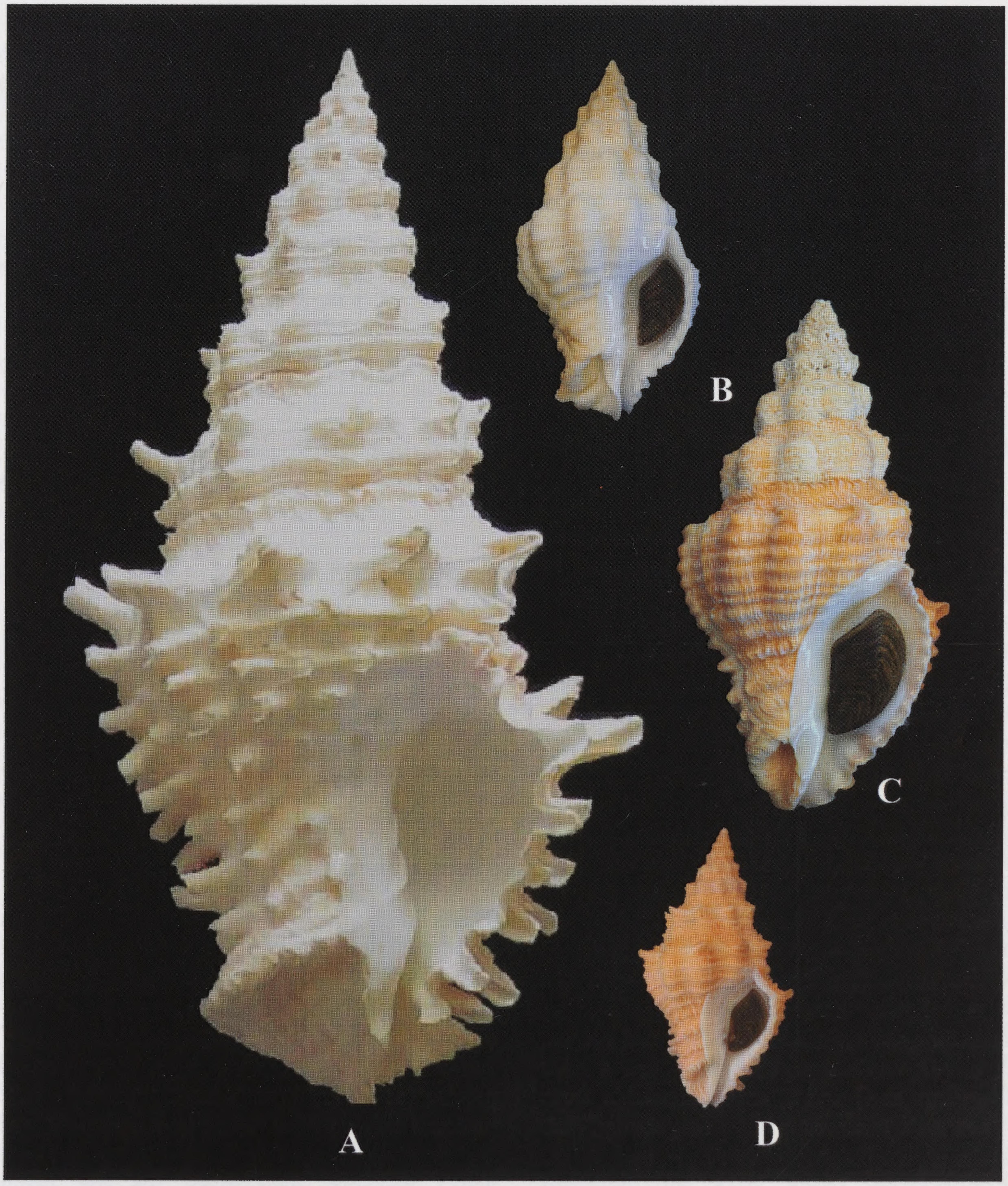

Figure 3. The current *Altivasum* Hedley, 1914 taxa shown in relative size: **A** = *Altivasum hedleyi* n. sp., Esperance, Western Australia (Weinreich collection, height 222.0 mm; **B** = *Altivasum profundum* Dekkers and Maxwell, 2018, off Augusta, West Australia, ROV-collected at 162 m, (WAM No. 72381, height 77.0 mm); **C** = *Alivasum flindersi* Verco, 1914, Port Lincoln, South Australia. Dived 10-20 meter in gravelly sand gutters (MNHN IM-2014-6965, height 110.3 mm); **D** = *Altivasum clarksoni* n. sp. Esperance, Western Australia, 30 m by diver (Collection of Trevor and Marguerite Young, paratype 1), height 62.0 mm.

A new species of *Amphidromus* Albers, 1850 from Krong Pac District, Dak Lak Province in the Central Highlands, Vietnam

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ABSTRACT This paper describes a new subspecies of *Amphidromus* Albers, 1850 from Krong Pac District, Dak Lak Province in the Central Highlands, Vietnam. Shell coloration and reduced pattern easily separate it from its nearest relatives *Amphidromus hongdaoae* Thach, 2017 and *A. davidmonsecouri* Thach, 2018.

KEY WORDS *Amphidromus*, *persimilis*, Krong Pac District, Dak Lak Province, Vietnam

INTRODUCTION

Two years ago, I received numerous snail shells from Anh Pham labelled as *Amphidromus species* collected at undisclosed locations in Dak Lak and Gia Lai Provinces, southern Vietnam. Even though Anh sent some duplicates to Dr. Thach, and after two books and several papers written by him, this left one Dak Lak snail unnamed. After some time on the market as *Amphidromus species*, it began circulating with an incorrect name, *Amphidromus pervariabilis* var. *protractus* Bavay & Dautzenberg, 1908 a shape variation of a North Vietnamese species. Earlier this year, Andy Tan was sure this snail deserved a separate name and he sent me six more specimens, all collected in Krong Pac District, Dak Lak Province (Figure 1). Armed with this data and further specimens, a study showed them to be quite consistent in shape and colour, with minor variability. This snail has a near solid-yellow shell and is easily separable from its nearest relatives and neighbours, *A. hongdaoae* Thach, 2017 and *A. davidmonsecouri* Thach, 2018, and described herein as a new species.

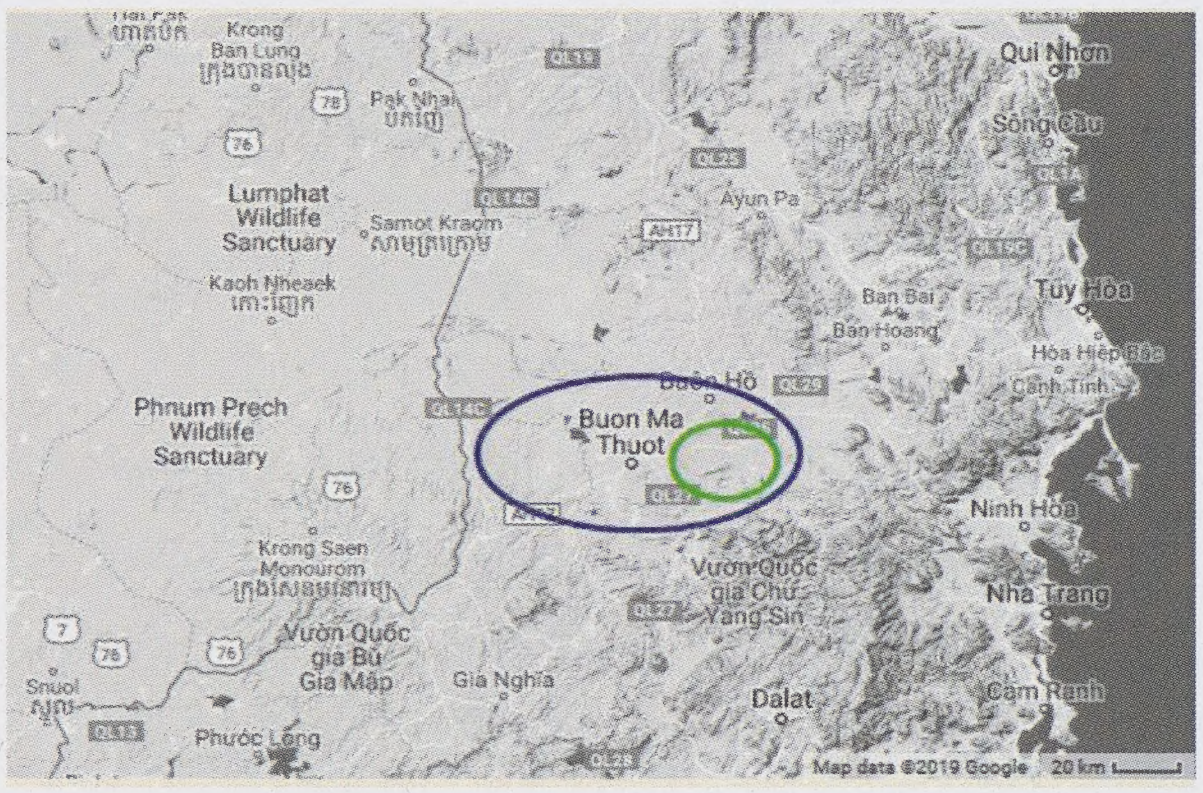

Figure 1. Location map showing the type locality (green oval) and range (blue oval) for *Amphidromus persimilis* n. sp. [Google Maps, 2019]

Materials and Methods

Shells were measured using digital Vernier callipers (0.01 mm resolution), sculpture examined under low magnification (10x) using a jeweler's loupe, and weighed using a pocket-sized electronic scale (capacity 300 g x 0.01 g). Whorl count includes the apex and counted precise to 0.125 (⅛ whorl). 'Paries' (adj. parietal) refers to the 'inner apertural wall' and 'palatum' (adj. palatal) is the 'outer apertural wall'. Relative shell sizes for the genus *Amphidromus* as a whole: small < 35 mm, medium 35-60 mm and large > 60 mm.

Abbreviations used for museums and private collections:

MNHN:	Muséum national d'Histoire naturelle, Paris, France
NBC:	Naturalis Biodiversity Center, Leiden, Netherlands
NHMUK:	Natural History Museum, London, England, UK
RMNH.MOL:	NBC specimen label code, ex-Rijksmuseum van Natuurlijke Historie
SMF:	Senckenberg Naturmuseum, Frankfurt, Germany
AT:	Andy Tan collection
JP:	Jeff Parsons collection

Abbreviations for shell morphometry, shell coiling and other:

D:	shell width (abbreviation for 'diameter' as per literature usage)
H:	shell height
H/D:	shell height/shell width ratio
N:	whorl count
W:	shell weight
DEX:	dextral coiling
SIN:	sinistral coiling
JP	data, observations, comments or other by Jeff Parsons
acq.	Latin *acquīsītus*, *acquīsītō* ablative, "acquired from"
leg.	Latin legit, "he or she collected"

SYSTEMATICS

Family Camaenidae Pilsbry, 1895
Genus *Amphidromus* Albers, 1850
Type species: *Helix perversa* Linnaeus, 1758

Amphidromus persimilis Parsons, new species
(Figure 2; Plate 1, figures 3-8, 15-20,
and Plate 2 figure 27)

Description. (holotype) Shell of medium-size, dextral, tapered-ovate, fairly solid and translucent. Spire long, apex subacute and protoconch punctulate. Very fine spiral wrinkles on teleoconch, overlain by growth lines and microthreads on early whorls and growth threads on mid-whorls; ridgelets sparse on spire and close-set on last whorl, coarser basally. Whorls 5⅝, convex apically and next ones subconvex. Last whorl not inflated, non-descending, weakly flattened above a rounded periphery and weakly compressed into a basal ridge near the umbilicus. Suture impressed apically, shallow thereafter, margin regular and subsutural region weakly subcompressed. Periostracum dull buff yellow, masking a gleamy surface below.

Shell almost plain, lower whorls lemon yellow with a faint albous sutural thread and a slightly darker yellow subsutural band, paler apically; early whorls whitish and apex black, fading as a brown apical swirl. A growth stoppage (mora) marks the boundary of the antepenult and penult, indicated by an opaque resting line and noticeable post-mora fading of ground colour. Aperture relatively small, oblique and subovate. Palatum gleamy white, moderately calcified and translucent, but masks external colour. Parietal callus colourless and thinly glazed, its margin very slightly thickened into a colourless parieto-columellar tubercle, falcate and extends c. 5 mm from columella's root. Outer lip gleamy white, strongly reflected, narrow and thickened, its terminus non-ascending; lip face and outer edge flat, lateral profile straight.

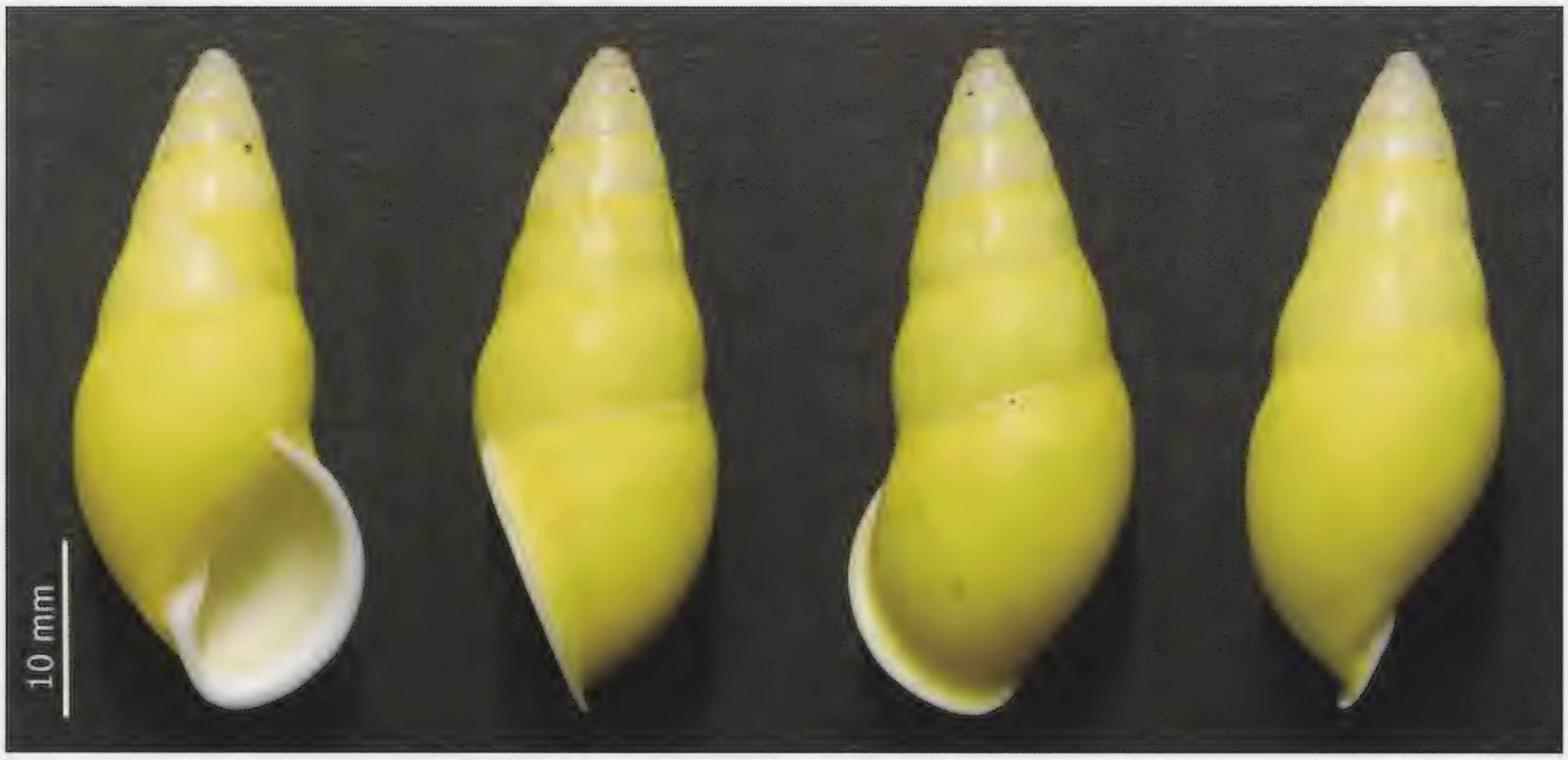

Figure 2. Holotype of *A. persimilis* n. sp. NHMUK 20190605/1 (photos by Jeff Parsons)

Type Material. Six adult shells, all from the type locality [leg. anonymous]. Holotype (DEX; NHMUK 20190605/1, Figure 2, and Plate 1, figure 3) H 36.94 mm, D 16.38 mm, H/D 2.26, N 7.625 and W 1.06 g. Paratypes 1-5 (2 DEX, 3 SIN; Paratype 1 NHMUK 20190605/2, Plate 1, figure 4; others AT, Plate 1, figures 5-8), H 32.84-36.87 (av. 35.08) mm, D 15.28-16.33 (av. 15.81) mm, H/D 2.15–2.30 (av. 2.22), N 7.25-7.625 (av. 7.375) and W 0.65-1.15 (av. 0.872) g.

Other Material Examined. Seven adult shells, type locality (2 DEX, 3 SIN, leg. Pham Ngoc Anh; 1 DEX, acq. Huynh Anh; Plate 1, figures 15-20) and Cu Jut District, Dak Nong Province (1 SIN, acq. Cillan & Don Chan; Plate 2, figure 27) [JP, Figures. 3C-F], H 33.06–38.03 (av. 35.75) mm, D 15.34-17.92 (av. 16.49) mm, H/D 2.02-2.34 (av. 2.17), N 6.875-7.625 (av. 7.357) & W 0.74-1.18 (av. 0.941) g.

Type locality. Krong Pac District, Dak Lak Province in the Central Highlands, Vietnam (Figure 1) .

Distribution. Also known from Buon Don District, Dak Lak Province (anonymous source) and Cu Jut District, Dak Nong Province.

Ecology/Habitat. Found among cultivated medicinal herbs at type locality, and found on trunks, limbs and branches, and in hollows of various trees in native forest.

External features of animal. Unknown.

Soft parts. Not available for study.

Etymology. Latin *persimilis* meaning “very similar” due to it being of a similar appearance to its nearest relatives.

Shell Variation. Very little variation to remark on. This species is amphidromine, producing either dextral or sinistral shells. All have the suture very faintly whitened and yellow lower whorls. Most are lemon yellow with a slightly darker yellow or orange-yellow subsutural band, except one that is orange-yellow with an orange subsutural band, with the orange tone washed out in the photo (Plate 1, figure 16). Most have a white protoconch, except dull purple in one shell (Plate 1, figure 19) and early whorls grey in another (Plate 1, figure 18). Apex with a black dot or a black spot that covers much of the first whorl and fades to brown.

Shape is stable, with the upper surface more or less flattened than the holotype. Spire is moderately long or long, generally narrowly tapered, less so in some. Some shells have a less developed basal and the outer lip terminus may by slightly ascending. Palatum moderately calcified in most, less so in some with external colour weakly showing through. Columella as per holotype or somewhat dilated above.

DISCUSSION

A. hongdaoae (Plate 1, figures 9-14) and *A. davidmonsecouri* (Plate 2, figures 21-26) are similar in being amphidromine. Although the type of *A. pervariabilis* var. *protractus* (Figure 9) is sinistral, the species is amphidromine. *A. semitessellatus* (Morlet, 1884) (Plate 1, figure 9) and *A. rhodostylus* Möllendorff, 1901 (Plate 2, figures 32-38) differ in being known only from sinistral shells, and *A. dautzenbergi* Fulton, 1899 differs in having only dextral shells.

A. hongdaoae is of a similar size and similar weight. Differs in having a white spire with chocolate-brown markings, often changing to purple on the penult and sometimes extending onto the last whorl (Plate 1, figure 9), but commonly confluent with a subunicoloured last whorl (Plate 1, figures 10 & 12). Sometimes there are yellow supermedial and submedial bands (Plate 2, figures 11, 13-14). It has a blackish or yellow circumumbilical band and purple or black umbilical interior. Periostracum is olive tinted with or without darker streaks, last whorl sculpture is much finer, the columella has a purplish stain and it lacks a basal ridge.

A. davidmonsecouri is of an equal size or larger and equal weight or heavier. Differs in typically having a sub-unicoloured shell (Plate 2, figure 23), being mostly yellow & white superior zone, but may also be white with yellow bands (Plate 2, figures 21-26) or mostly white (Plate 2, figures 22, 24-25). The subsutural band is orange-yellow, rose red (Plate 2, figure 22) or rose red changing to pomegranate purple near the lip (Plate 2, figure 25). It commonly has a purple or black umbilical interior and a dual-coloured circumumbilical band (black plus dark vinaceous outer border), or that is yellow (Plate 2, figure 24). Periostracum is almost colourless with olive streaks to olive tinted with darker streaks, last whorl sculpture is weaker and more widely spaced or much finer, the columella has a purplish stain and it lacks a basal ridge.

A. semitessellatus is of an equal size or smaller with a weaker sculpture. Differs in having lower whorls yellow tinted covered by a yellowish fawn periostracum, violaceous-nigrescent subsutural band, sometimes a similar coloured basal band and upper whorls have two irregularly, interrupted castaneous zones. It has a larger aperture and a less elongated, wider spire.

A. rhodostylus is of an equal size or larger. Differs in typically having a white or yellow shell with a brown subsutural band and brown circumumbilical band (Plate 2, figure 33). The subsutural band may be reddish (Plate 2, figure 34) or the circumumbilical band is wider and a black-brown basal band (Plate 2, figure 35). Differs in having various patterns with a narrow zone of ground colour below the suture, such as upper whorls streaked with dark brown, the last fire red with fading blackish stripes (Plate 2, figure 36). Brown streaks fading toward the aperture (Plate 2, figure 37) or those on the base merge to form a sub-confluent zone (Plate 2, figure 38) or broad brown stripes all over. Streaks merge with last two whorls monochrome brown, with a greenish or reddish tinge (Plate 2, figure 20). Periostracum may have greenish lines behind the lip and the columella has a reddish stain.

A. dautzenbergi is slightly larger, has a similarly tapered base lacking a basal ridge, wider spire and larger aperture. Suture has an obsolescent subangular periphery, a wider white margin, paler ground colour and lacks a coloured subsutural band. It has obscure spiral striae crossed by weak transverse sculpture and the last half whorl is indistinctly malleated, and flared outer lip.

A. pervariabilis var. *protractus* is larger and of a similar shape. It has a similarly tapered base with a more developed basal ridge. Differs in have a greyish white shell and lacks a coloured subsutural band. The species itself has a wide range in size and shape, protoconch is whitish with or without a dark brown or reddish apex, which when present the colour may extend onto the protoconch. It is sometimes imperforate, has coarser spiral striations and much weaker transverse sculpture. It has a deciduous and lutescent periostracum, which is virescent on the base of the last whorl, and a slightly flared or reflected outer lip.

A. (*Syndromus*) *adamsii* var. *aureocinctus* is of a similar size, smaller or larger and similar shape, although more convex whorls. Overall coloration and pattern features are similar, but with a greater contrast between ground colour and subsutural band. The ground is a faint greyed yellow, subsutural band is golden yellow and periostracum is yellowish fawn and somewhat shiny, columella is abapertural and the umbilicus almost or is closed.

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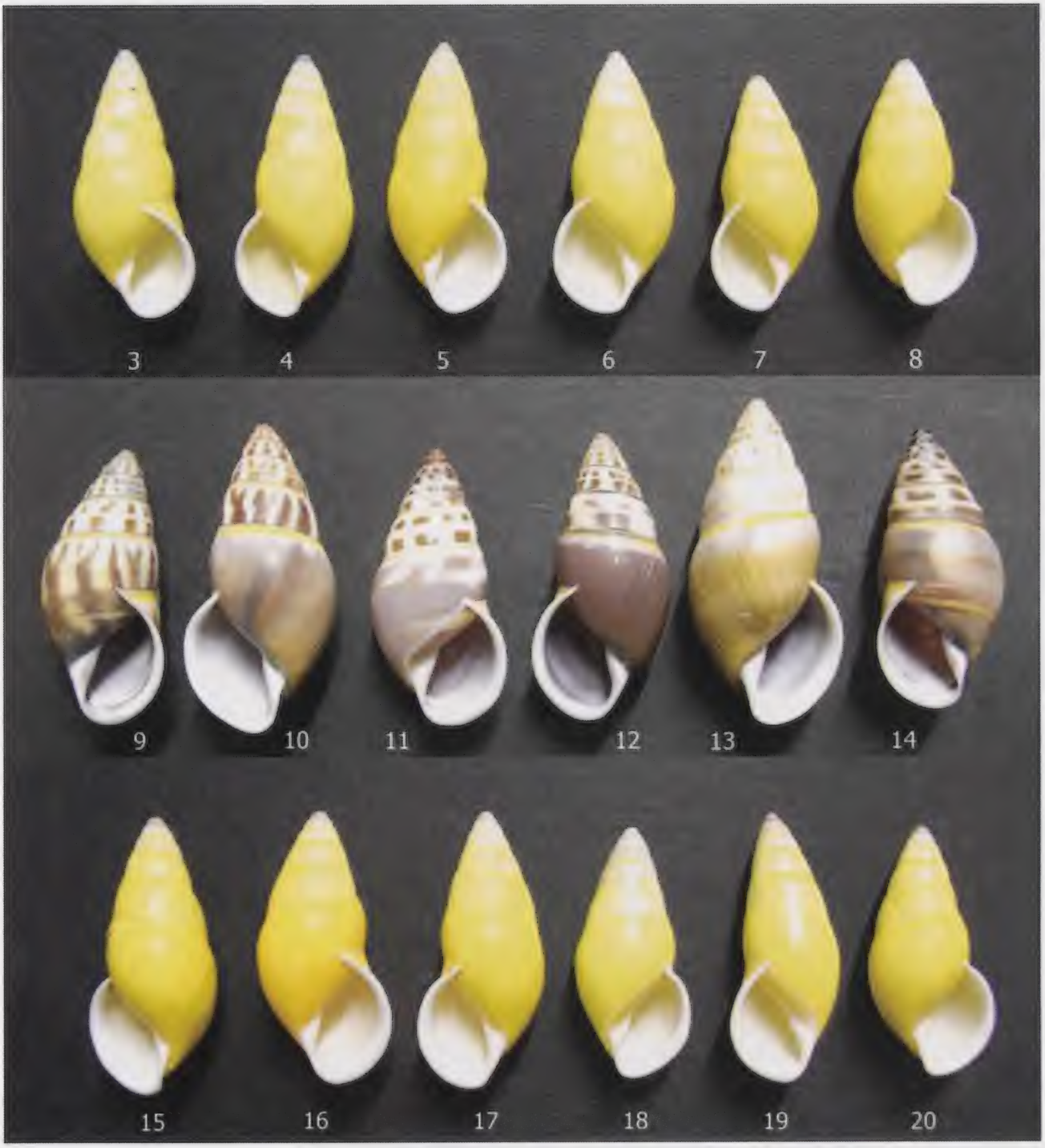

Plate 1. ***Amphidromus persimilis*** **n. sp. compared to** ***A. hongdaoae,*** **with figure numbers listed below.**
First row, figs. 3-8 type specimens of *A. persimilis* n. sp., **3** holotype, **4** paratype 1, **5-8** paratypes 2-5;
Second row, figs. 9-14 *A. hongdaoae* Phu Thien District, Gia Lai Province (**11** bleached);
Third row, figs. 15-20 *A. persimilis* n. sp. non-type shells from the type locality: **15** shell 7, **16** shell 8, **17** shell 9, **18** shell 10 (bleached), **19** shell 11 (bleached) and **20** shell 12.

[Photo credits: **3-25** JP; **26** Maestrati, 2012 - MNHN; **27** Caballer, 2019 - MNHN; **28** Natural History Museum, 2019a; **29** Natural History Museum, 2019b; **30** Bioportal, 2016; and **31-36** in B/W as published on Plate 22 in Zilch, 1953]

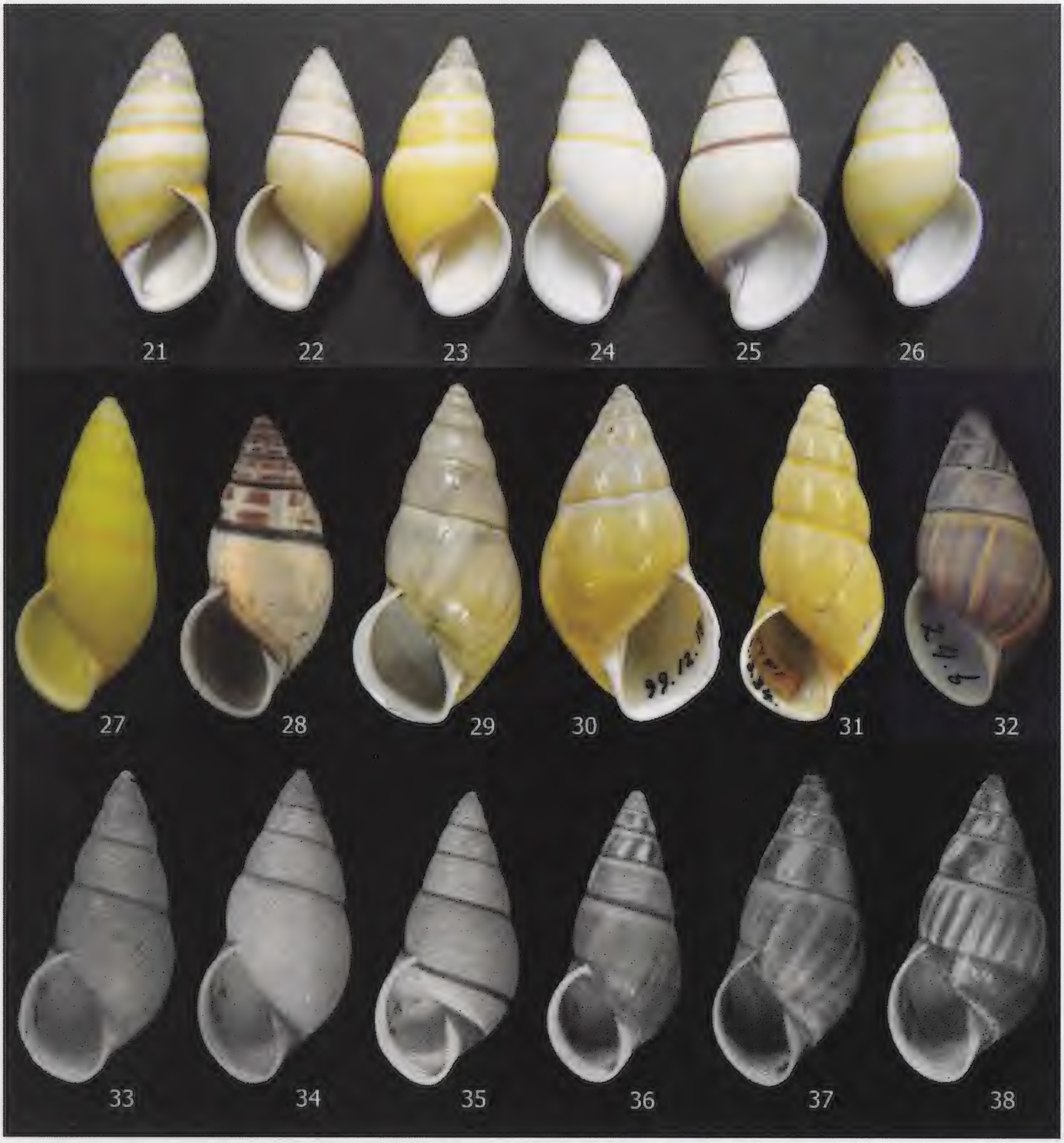

Plate 2. Comparison with various other *Amphidromus* species, with figure numbers listed below.
First row, figs. 21-26 *A. davidmonsecouri* Krong Bong District, Dak Lak Province
Second row, fig. 27 *A. persimilis* n. sp. non-type shell from Dak Nong Province, shell 13; and **figs. 28-32** congeners from Cambodia, Borneo and Vietnam: **28.** *A. semitessellatus* lectotype MNHN-IM-2000-1985 Kampot Province, S. Cambodia. **29.** *A. pervariabilis* var. *protractus* syntype MNHN-IM-2000-2051 Lao Cai Province, N. Vietnam. **30.** *A. dautzenbergi* holotype NHMUK 1899.12.18.38 N. Vietnam. **31.** *A. adamsii* var. *aureocinctus* lectotype NHMUK 1896.6.13.34 N. Borneo. **32.** *A. rhodostylus* var. *subconfluens* RMNH.MOL.288417 (yellow-lipped variant) Pha-rang, Ninh Thuan Province, Vietnam
Third row, figs. 33-38 named variations of *A. rhodostylus*, all holotypes from Pha-rang, Ninh Thuan Province, Vietnam: **33** *simplex* (typical form) SMF 122336, **34** *roseolineatus* SMF 122337, **35** *nigrolineatus* SMF 122338, **36** *igneus* SMF 122339, **37** *rhabdotus* SMF 122340 and **38** *bipartitus* SMF 122342.

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A review of the *Voluta polypleura - demarcoi* complex

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ABSTRACT The *Voluta polypleura - demarcoi* species complex of the Caribbean Province volutid fauna are reviewed, illustrated, and a number of taxa are revised.

KEY WORDS Volutidae, *Voluta*, Caribbean Province, Nicaraguan Subprovince, allopatric species

INTRODUCTION

There has been much confusion concerning the *Voluta polypleura - demarcoi* complex in the literature due to the apparent loss of Crosse's holotype from 1876. As shown herein this species complex represents an endemic radiation of at least ten species of Volutidae on the isolated offshore banks and muddy coastal areas of the Nicaraguan Subprovince of the Caribbean Province. These volutes are direct developers with nonplanktonic larvae and because of this, they have become isolated on offshore banks and seamounts since the late Pleistocene, consequently they have evolved into closely related allopatric species (Petuch, 2013). A recent study of this group by Edward J. Petuch found that the name *Voluta polypleura* Crosse, 1876 was misapplied to *V. demarcoi* Olsson, 1965. The true *polypleura* has a much smaller and more compact shell and completely lacks any "music lines or musical staff pattern" on the body whorl (Crosse, 1876; Poppe & Goto, 1992; Petuch, 2013).

The apparent loss of the type specimen of *V. polypleura*, was reversed by the rediscovery of the true *polypleura* with several live specimens collected from the Caratasca Cays and Vivorillos Cays of Honduras. This led to the designation of a neotype deposited with the United States National Museum as USNM 89431 (Petuch, 2013). In researching this complex I performed an exhaustive on-line search of major museums and was surprised to discover that the holotype of *V. polypleura* has been housed at the National Museum, Liverpool, England; it's accession number is LIVCM 2.4.1885.17[124]. This makes Petuch's designation of a neotype unnecessary. It is important to note that Crosse did not have accurate locality data and therefore Petuch's specimen, which has detailed locality data, fixes the type locality as the Caratasca Cays of Honduras. Specific reference is made to the remarkably true to life original painted line drawing of Crosse and the modern photograph of the holotype of *polypleura* (Figure 1), which when compared to *V. demarcoi* shows that it is a different distinct species and removes it from synonymy with *polypleura* (see Figure 2).

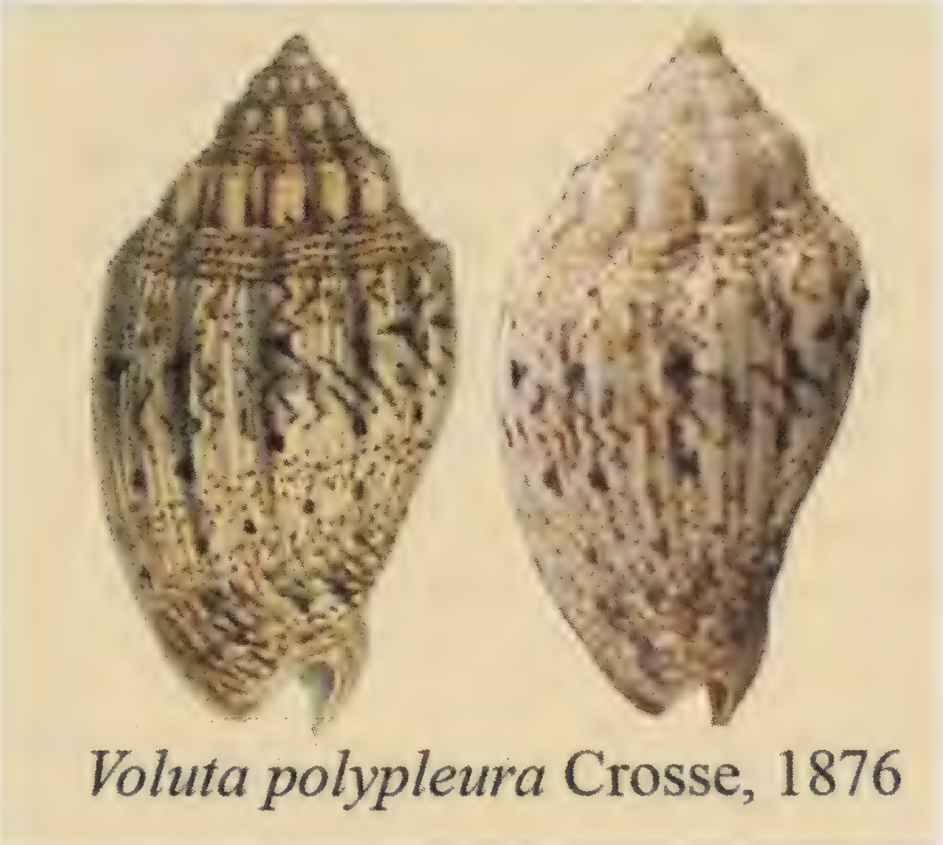

Figure 1. Original painted line drawing of the holotype of *V. polypleura* Crosse, 1876 on the left, and a modern digital photograph of the holotype on the right.

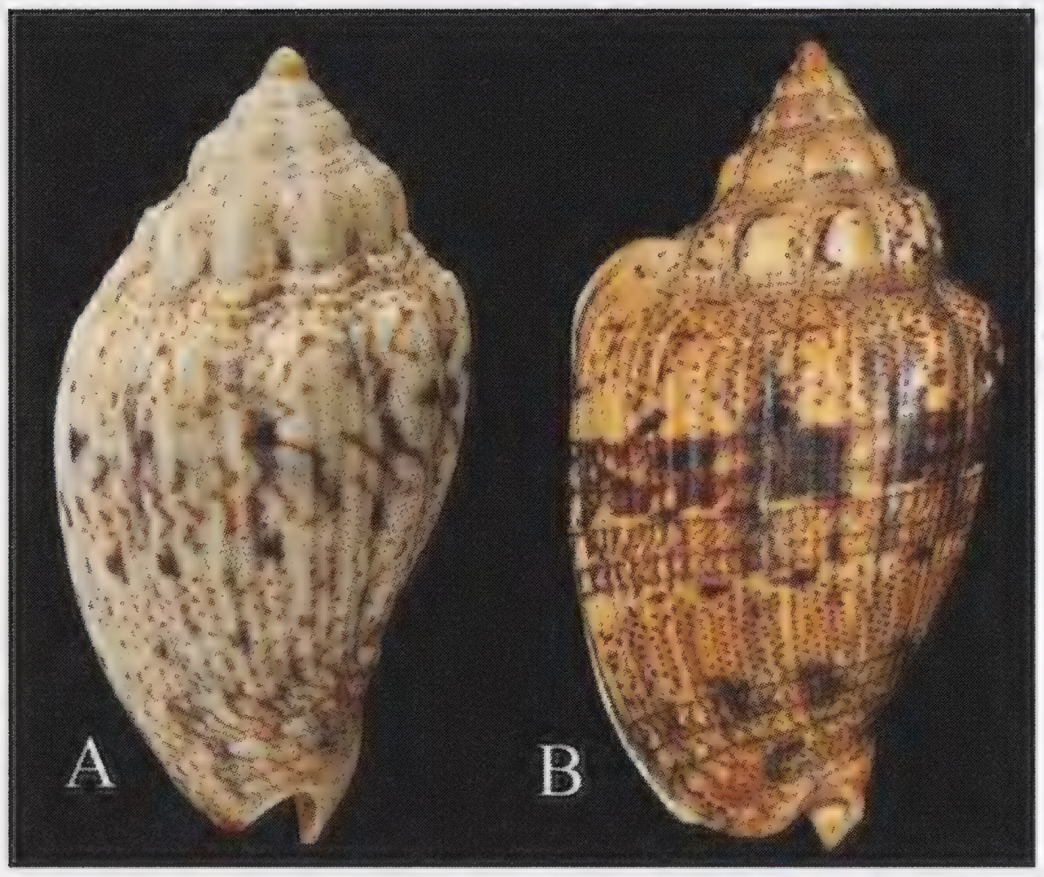

Figure 2. Comparison between species. A = *V. polypleura* holotype 56 mm, National Museum, Liverpool, England. LIVCM 2.4.1885.17[24]; **B =** *V. demarcoi* holotype 84.6 mm, USNM 637275. Both specimens are shown the same size in this figure for comparison.

Due to the confusion surrounding the identity of the true *V. polypleura*, a relatively rare species, photographs of the larger and more common *V. demarcoi* have been mistakenly published as *polypleura*. That mistake has now been rectified and *V. demarcoi* is recognized as a full valid species.

Color digital photographs of type specimens of all of the named species in the *Voluta polypleura - demarcoi* complex have been obtained and are illustrated here together with the description of each taxon.

Abbreviations.
USMN = United States National Museum

SYSTEMATICS

Gastropoda
Caenogastropoda
Neogastropoda
Volutacea
Volutidae
Volutinae
Voluta Linnaeus, 1758

SPECIES ACCOUNTS

Voluta polypleura Crosse, 1876
(Figures 1, 2A, 3A)

Holotype. National Museum, Liverpool, England. LIVCM 2.4.1885.17[124]. Length 56 mm.

Original description. "Obtuse tuberculata, lineolis transversis pecularibus omnio carens, albida, saturate fusco maculata, castaneo multiplicata; spira mediocriter elongata, apice rotundato, obstuso, corneo; sutura subirregulariter impressa; anfractus 7, primi embryonades 2 ½, cornei, sequentes valide tuberculati, in vicinio suturae, sulcis transversis 4 impressi, ultimus ascendes, spiram superans, tuberculis in costas longitudinales desinetibus ornatus, interstitis costarum costulas minores gerentibus, versus medium zona interdum subevanida linearum castanearum, fulguratim dispositarum cinctas; apertua elongata, angusta, albida; peristoma albidum, margine columellari plicis 11 (8 validis, 3 minoribus) munito, externo albido, unicolore, maculis nigris destituto. - Long. 56 diam. maj. 30 mill. apertura longa, 10 lata." (Crosse, 1876)

Translation / Transliteration. Bluntly tuberculate, without any special crossing lines, whitish, with dark chestnut brown spots increasing; the spire moderately elongate, with rounded apex, bluntly, knobbed; suture irregularly impressed; 7 whorls, 2½ nuclear whorls, shoulders with knobs following the early whorls, sutures in the area between whorls, small spots across the 4 upper whorls tops, upper whorls have knobs on the longitudinal ribs, the space between the knobs increasing with growth, a band of chestnut brown irregular lines or flammules near the middle of the body whorl, aperture long, narrow, whitish; 11 white columellar plicae (8 major, 3 minor) strong external margins white, uniform color, dark spots fading - 56 mm long, aperture 30 mm long, 10 mm wide.

Revised Description. Protoconch large, bulbous, consisting of 3 whorls, colored tan-brown; spire high; suture weakly defined; subsutural area ornamented with 3-4 coarse spiral cords; shoulder smooth, rounded; body whorl with 8-9 rounded axial ribs which form weak knobs on the shoulder, minor growth lines or plications between the axial ribs; outer lip adherent to the side of the body whorl, rounded, thickened; columella with 8 large smooth plications and 3 minor plications; base shell color, aperture and columella creamy white; body whorl with 2 bands of longitudinal medium brown zigzag flammules with intermittent dark brown spots above and below the band; one major band around mid-body, one minor band around anterior end; base color on body whorl and spire whorls overlaid with scattered patches of small brown dots.

Distribution. Endemic to the Caratasca and Vivorillo Cays, Honduras (Petuch, 2013).

Discussion. Despite being the oldest named species in the complex *V. polypleura* remained an enigma for over a century because the holoype was lost or misplaced and Crosse did not have accurate locality data. With the rediscovery of the holotype it is clear that this rare and elusive species significantly differs from its often confused sister species *V. demarcoi* in that it has a smaller more compact shell, narrower more rounded shoulder, and completely lacks any of the fine lines around the body whorl that are considered to be a diagnostic feature in many of these volitid species. Given that the holotype has been located in Liverpool the designation by Dr. Petuch of a neotype, which he deposited with the United States National Museum, is moot.

Voluta demarcoi Olsson, 1965
(Figures 2B, 3B)

Holotype. USNM 637275.
Length 84.6 mm.

Description. "The shell is medium or large size, ovate, solid, with an elevated spire, of about six whorls (including the nuclear ones) about half the length of the aperture. The protoconch is relatively large, bulbous or cap shaped composed of about 1½ turns, and in the type specimens colored a pale rosy brown. All whorls have rounded shoulders, and on the body whorl, the shoulder is placed high, opposite to the end of the aperture; on the whorls of the spire, the shoulder lies a little above the middle. The body whorl is large, subelliptical, forms most of the surface, and is only a little longer than the length of the aperture, its shoulder bearing about eight low nodes which fade-out below. There are similar shoulder nodes on all the whorls of the spire and appear larger as they undulate the whole visible surface. Suture are widely appressed, the zone sculpted with coarse, spiral cords. In addition to the shoulder nodes, the surface of the body whorl is covered with smaller axials or longitudinal ridges resembling enlarged, crowded growth lines. Coarse spiral threads cover the sutural zone and around the base of the body whorl. The spirals are particularly strong on the whorls of the spire, encroaching lower to cover the shoulder nodes as well. The aperture is elongate, the outer lip thickened in the adult, its margin within smooth. A series of long lirae or plaits (about 14) cover the length of the inner lip, the two lowest being the strongest, narrower and weaker above, some with a tendency of alternating in size. There is a spread of callus over the parietal wall outward. The base color is a mellow rose or pinkish brown, overlain by a zoned pattern of large, brown blotches crisscrossed by brown lines and small brown spots. The anterior canal is short, encircled by a large folded fasciole terminating in a wide siphonal canal notch bordered by a raised edge. Length 84.6 mm., diameter 42 mm." (Olsson, 1965)

Distribution. A coastal species found between Cabo Camaron, Honduras to Puerto Cabezas, Nicaragua (Petuch, 2013).

Discussion. Olsson compared his new taxon *demarcoi* to *polypleura* which he noted was only known from its figure, however its pattern was "so different from all other members of the genus that it can be accepted for the present as a distinct species." Olsson opined that the holotype of *polypleura* is "probably in the Paris museum." This larger, heavier, broader shouldered species also differs from *polypleura* in that it has a strong zoned pattern of large brown blotches, small brown spots, and bands of fine brown lines that have been compared to "music lines or musical staff pattern" encircling the body whorl. Crosse made a point of stating in his description of *V. polypleura* that it did not have the distinctive band of fine brown lines which was characteristic of *V. musica* Linnaeus, 1758 (Crosse, 1876).

Voluta morrisoni (Petuch, 1980)
(Figure 3C)

Holotype. USNM 784485.
Length 73.4 mm.

Description. "Shiny, highly polished; body heavy, thickened, with 4 to 5 whorls; body whorl with 7 to 12 rounded major axial ribs and 30 to 60 sharply defined minor axial ribs; spire elevated, turriculate; shoulder angled with blunt coronations; spire whorls with 3 or 4 raised, beaded spiral cords; protoconch large with 3 bulbous, smooth whorls; aperture elongate, roughly $^{2}/_{3}$ of total shell length; columella with 8 or 9 major plications and 3 to 6 minor plications; plications heavily beaded; outer lip thickened and flaring in adults; color of base of shell salmon-pink to rose-red with 6 to 8 evenly-spaced revolving bands of black and white spots; base color overlaid with numerous fine red-brown specklings and scattered large dark brown blotches; protoconch salmon-orange; interior of aperture pale pinkish white turning white toward outer lip; columellar region and plications salmon-pink; outer lip white with 11 to 14 raised black denticulations; operculum unknown." (Petuch, 1980)

Distribution. Endemic to Rosalind and Serranilla Banks between Honduras and Jamaica (Petuch, 2013).

Discussion. Originally named in the genus *Falsilyria* following the trend for fossil species as reflected in Hoerle & Vokes, 1978, as the second known living species in the complex, and is sympatric with *Falsilaria demarcoi* (which was originally named under the genus *Voluta*). Differs from *demarcoi* in that it has a higher spire, more acutely angled shoulder, less numerous and heavily beaded columellar plications, a proportionately larger protoconch, raised beaded cords on the spire, and lacking the bright orange or peach base color, which is characteristic of *demarcoi*. The beaded columellar plications are a unique feature among living species, and closely resemble the beaded plications of the fossil species *F. mansfieldi* (Dall, 1919) (Hoerle & Vokes, 1978; Petuch, 1980).

Voluta garciai (Petuch, 1981)
(Figure 3D)

Holotype. USNM 784641.
Length 63 mm.

Description. "Shiny, polished; heavy body, with 5 whorls; body whorl with 10 rounded axial ribs; all whorls with numerous sharply-defined minor axial ribs; anterior ¼ of shell with 7 large, raised, beaded cords; shoulder sharply defined, strongly coronated; high spire, scalariform; spire whorls coronated, with 7 large, raised, beaded cords; 3 cords on shoulder, enhancing coronated appearance; protoconch glassy, composed of 3 whorls; aperture narrow, roughly $^{3}/_{5}$ of shell length; columella with 9 sharp-edged plications; base shell color cream-orange with 2 bands of deep purple-blue and sky-blue blotches; one band around midbody, one band around anterior end; base color overlaid with numerous longitudinal dark brown zigzag flammules, some running entire length of shell; shoulder with scattered patches of dark brown dots; spire whorls blue-gray with radiating, fine, dark brown zigzag lines, that cross over raised spiral cords, giving them speckled appearance; protoconch tan; interior of aperture flesh-pink; columellar region orange, becoming darker at anterior end." (Petuch, 1981)

Distribution. Gorda Bank to Trujillo Bay, Honduras (Petuch, 2013; Robert Masino - personal communication).

Discussion. *V. garciai* is the only species in the *V. polypleura - demarcoi* complex other than *V. polypleura* with a color pattern of zigzag flammules. It is similar to *V. morrisoni* in that it has heavily sculpted spire whorls and sharp angled shoulder coronations (Petuch, 1981). *V. garciai* appears to be most similar to *V. demarcoi* in both its spire sculpture, cords, and overall color pattern, however like *V. polypleura* it lacks the bands of fine brown lines or "music notes" characteristic of most species in the complex. Since the only known specimens are subadults it is unclear what other features will be apparent in a fully developed adult specimen. With the collection of further specimens and future research *V. garciai* may prove to be most closely related to *V. demarcoi,* having only been geographically isolated since the Pleistocene glacially-induced sea level fluctuations. It is likely that *V. garciai* is a subspecies of *V. demarcoi* in the process of speciation.

Voluta kotorai (Petuch, 1981)
(Figure 4A)

Holotype. USNM 784642.
Length 49 mm.

Description. "Shiny, polished; heavy body, thickened, with 4-5 whorls; body whorl with 7-10 rounded axial ribs; last whorl with numerous sharply-defined minor axial ribs toward edge of lip; spire low, roughly ¼ - $^{1}/_{5}$ total shell length; spire whorls with 3 undulating, beaded spiral cords; protoconch very large for genus, with 3 bulbous whorls; aperture large, wide, lenticular, roughly ¾ of total shell length; columella with 12-14 thin, smooth, sharp-edged plications; lip thickened and flaring in adults; base color bright salmon-pink with 2 wide bands of wine-red and purple blotches, one band posterior to midbody line, one anterior; base color overlaid with 5-7 evenly-spaced revolving bands of black and white spots and secondary system of numerous evenly-spaced revolving brown lines connected by short, staggered, longitudinal lines, producing "brick wall" pattern; protoconch white at tip, turning to orange; interior of aperture salmon-pink, becoming orange towards edge of lip; edge of lip white with numerous black spots; columella orange, with white plications." (Petuch, 1981)

Distribution. Offshore on the Corn and San Andres Islands, Nicaragua, and Gorda, Roncador, Quitasueňo, and Serrana Banks (Petuch, 2013).

Discussion. *V. kotorai* differs from *V. demarcoi* in having a proportionately larger protoconch, a lower spire, and lacks both the bright orange-peach base body color and fine brown speckling that is characteristic of *V. demarcoi*. *V. kotorai* differs from the closely related species *V. retemirabila* in having a proportionately larger protoconch, a red and pink base body color, and in having a coarse "brick" pattern rather than a fine "net" pattern composed of fine brown lines (Petuch, 1981). *V. kotorai* is one of the most distinctive and attractive members of the *V. polypleura - demarcoi* complex.

Voluta retemirabila (Petuch, 1981)
(Figure 4B)

Holotype. USMN 784643.
Length 75 mm.

Description. "Shiny, highly polished; body thick, heavy, with 5 whorls; body whorl smooth, with 11 low, flattened axial ribs; anterior ¼ shell with 4 wide, raised spiral cords; shoulder rounded, smooth; spire high; early spire whorls heavily sculpted with raised spiral threads, with later whorls smooth; 3 slightly raised spiral threads on last spire whorl; protoconch glassy, composed of 3 whorls; aperture large, flaring, roughly ¾ total shell length; columella with 15 plications, 5 of which are larger than others; base shell color cream-yellow with 2 continuous bands of blue-gray, one above midbody line, one at anterior end; base shell color overlaid with numerous intermeshing, horizontally and vertically-oriented rows of tiny brown dots which form a fine net pattern over entire shell; net pattern, in turn, overlaid by 10 wide, revolving bands of alternating dark brown and violet-blue dashes; protoconch white at tip, turning orange; interior of aperture flesh-colored; columella cream-yellow with white plications." (Petuch, 1981)

Distribution. Endemic to Misteriosa Bank, between Belize and the Cayman Islands (Petuch, 2013).

Discussion. The protoconch of *V. retemirabila* is larger and more bulbous than *V. demarcoi*, and smaller than *V. kotorai*. Its fine net pattern and brilliant coloration are unique among the other members of the *V. polypleura - demarcoi* complex.

Voluta harasewychi (Petuch, 1987)
(Figure 3E)

Holotype. USNM 784486.
Length 45 mm.

Description. "Shells small for subgenus, elongated, thickened; body whorl shiny, polished, with few thin, low, axial ribs; shoulder with 8-10 low, rounded knobs; subsutural area with 2-3 large, spiral cords; columella curving at posterior end, with 10-12 thin, heavily pustulated plications; shell white, overlaid with 8-10 evenly-spaced bands of large black and white dashes; spaces between bands of dashes completely covered with tiny, dark brown speckles; speckled and dashed color pattern, in turn, overlain with interrupted bands of flammules of bright red; columella and aperture white; edge of lip with numerous, evenly-spaced black dashes; protoconch large, salmon-orange, dome-shaped." (Petuch, 1987)

Distribution. Endemic to the north coast of Roatan Island, Honduras (Petuch, 1987; Petuch, 2013).

Discussion. *V. harasewychi* is most closely related to *V. morrisoni*, both of which are the only species in the complex with pustulated columellar plications. However, *V. harasewychi*, has a smoother shell with only a few axial ribs, smaller more rounded shoulder knobs, a much lower spire, a distinctly curved columella, the lip is adherent to the side of the body whorl and does not flare out, and this taxon has a consistently much smaller and stockier shell. *V. harasewychi* also has a sharper, well defined banded color pattern which lacks the large brown color patches seen on *V. morrisoni*.

(Petuch, 1987) The two species appear to be completely geographically isolated.

Voluta hilli (Petuch, 1987)
(Figure 4C)

Holotype. USNM 859871.
Length 88 mm.

Description. "Shell oval in shape, inflated, shiny. With high polish; body whorl ornamented with numerous low axial plications; shoulder with 10-12 large, rounded knobs; spire whorls heavily knobbed; margin of suture bordered with 4 large, raised, spiral cords; columella with 10-12 large plications; often with smaller, secondary plications between; shell base color salmon-pink overlaid with two, wide, bright orange bands, one around mid-body, one around anterior end; wide orange bands overlaid with numerous thin, pale brown spiral lines; base of each shoulder knob with conspicuous, large, dark brown blotch; area between wide orange bands with abundant tiny brown flecks and rows of alternating dark brown and white dashes; columella and aperture bright salmon-pink; edge of lip marked with row of large dark-brown or black checkers; protoconch cylindrical in shape with flattened top, yellow-salmon in color." (Petuch, 1987)

Distribution. Endemic from the Gorda Bank to the Cajones and Bercero Cays (Petuch, 2013).

Discussion. *V. hilli* is most closely related to *V. demarcoi* but differs in having larger and clearly defined shoulder knobs, having a pale salmon-pink body color, and two wide dark orange bands (Petuch, 1987).

Voluta sunderlandi (Petuch, 1987)
(Figure 4D)

Holotype. USNM 859903.
Length 53 mm.

Description. "Shell small for genus, short and stocky; whorls with 9 large, rounded axial ribs per whorl; axial ribs angled at shoulder, knoblike; subsutural area between shoulder and suture with numerous large, raised spiral cords; anterior end of shell with 6 incised sulci; rest of body whorl smooth, without spiral sculpture; base color white or pale pink with bands of large, evenly-spaced brown dots that are, in turn, separated by 3 evenly-spaced, solid, reddish-brown lines around mid-body; solid mid-body lines connected together by evenly- spaced, large, pale purple spots; columella with 10 large, smooth, plications, with several secondary plications in between; interior of aperture and columella white; protoconch large, rounded, dome-like, white in color." (Petuch, 1987)

Distribution. Endemic to Utila Island and the adjacent coastline, Honduras (Petuch, 2013).

Discussion. *V. sunderlandi* has the stockiest and most rotund shell in the *V. polypleura* - *demarcoi* complex. *V. sunderlandi* is morphologically closest to *V. demarcoi* and is distinguished by having a smaller more inflated shell, stronger axial ribs and shoulder knobs, lower spire, fewer and coarser columellar plications, white or pinkish-white base color, narrower and less developed mid-body color band, and white protoconch (Petuch, 1987).

Voluta ernesti (Petuch, 1990)
(Figure 4E)

Holotype. USNM 860539.
Length 54 mm.

Description. "Shell narrow, elongated, fusiform, thick and heavy; spire elevated, protracted; spire whorls slightly convex in outline; whorls ornamented with 8-10 large, rounded, axial plications; large plications overlaid with numerous thin, riblike plications; shoulder angled, bordered by a single large spiral cord;

subsutural areas sculptured with 3 large spiral cords; subsutural spiral cords intersect with thin axial riblets to produce beaded texture on shoulder and spire; body whorl shiny, polished; anterior end sculptured with 5-6 spiral cords; columella slightly arcuate, with 11-12 thin, smooth plications; outer lip of adults thickened, projecting posteriorward; protoconch proportionately large, rounded, domelike; shell color pale salmon-yellow with 2 wide bands of brown and purple checkers and spots, one around mid-body and one around anterior end; mid-body band overlaid with 4-6 brown spiral hairlines and numerous tiny brown vertical flammules; anterior band similarly marked with 5 brown hairlines and tiny vertical flammules; salmon-yellow areas between wide colored bands completely overlaid with closely-packed, tiny orange-brown speckles; protoconch light tan; columella and interior of aperture pale salmon; edge of lip yellowish-white, marked with evenly-spaced dark brown spots." (Petuch, 1990)

Distribution. Found between Punta Gorda, Honduras and the San Blas Islands, Panama (Petuch, 2013).

Discussion. Inhabiting the Blasian Subregion *V. ernesti* is the southernmost taxon in the *V. polypleura - demarcoi* complex. *V. ernesti* is most similar to *V. demarcoi* and is distinguished by its smaller, slender, elongated shell, more sharply-angled shoulder, and less colorful pale salmon-yellow base color compared with the consistent deep orange base color of *V. demarcoi* (Petuch, 1990).

Voluta "brunneocincta" Poppe, 2001
(nomen nudum - not figured)

Distribution. From Roatan, Honduras.

Discussion. *V. "brunneocincta"* was not described or named as a species, but rather was a form name applied to a dark variant *V. hilli* specimen found at the northern end of its range. This name has been incorrectly used in the popular literature as though it were a formally named species. An beautiful specimen of this color form is figured by Guiddo Poppe in his book "Exceptional Shells from the Guido T. Poppe Collections" (Poppe, 2001).

DISCUSSION

These ten taxa in the *Voluta polypleura - demarcoi* complex are poorly known due to their isolated habitat, and the lack of any serious coordinated effort to study them in their natural environment. Most specimens of these extraordinary volutes only come to the surface as part of the bycatch of shrimp trawlers and lobster fishermen who work vast areas of the sea to catch food for human consumption, and notoriously provide misleading locality data in an effort to protect their rich fishing grounds. Accordingly, locality data on the specimens acquired through trawlers is often inaccurate at best.

The misplacement of the type specimen of *V. polypleura* Crosse, 1876, for well over 140 years, together with inaccurate locality data for the types of both *V. polypleura* and *V. demarcoi*, and the paucity of specimens available for study contributed to the confusion regarding the *Voluta polypleura - demarcoi* complex. These factors, combined with difficulties in obtaining copies of scientific literature, poor quality images in older journals, and difficulty in viewing type specimens for study has only perpetuated the problem among collectors and in the popular literature (Poppe & Goto, 1992; Bail & Poppe, 2001).

Further, the fact that photographs of the holotypes of these species have not been widely disseminated, combined with the fact that specimens are scarce due to their isolated habitat, has led to the assumption that they are all merely color forms of *V. polypleura*. The advent of the internet, and museum databases with online access and high quality macro photographic images has opened the opportunity for taxonomic studies. High quality photographs of the holotypes of all ten species are shown together in Figures 3 and 4. Finally, setting aside the unique species specific color patterns and looking at shell sculpture alone, the author has provided a detailed side by side diagnostic comparison of the morphological differences between the ten species in the *Voluta polypleura - demarcoi* complex. (Table 1)

An understanding of these organisms' breeding habits, bathymetric preferences, and the biogeographic distribution of these mollusks is critical. A bathymetric color scale map showing the offshore banks, seamounts, cays, and islands where these species have been found is shown for reference. (Figure 5) Like most volutes these shallow water taxa are direct developers with nonplanktonic larvae. Given the oceanographic topography and the locations where these organisms have been found it is clear that most of them are geographically isolated on offshore banks and seamounts. The *Voluta polypleura - demarcoi* complex is the Caribbean parallel to the East Australian *Cymbiola "pulchra* complex" in this regard as it is comprised of a series of adjacent populations, geographically delimited and without noticeable overlap (Bail & Limpus, 1998). Only two of these volutid species have a coastal distribution: *V. demarcoi* and *V. ernesti*. In practical terms this means that each of the populations of these shallow water volutes are unable to interbreed with one another as they are surrounded by deep oceanographic barriers to dispersal. Accordingly, these populations have become genetically isolated and have evolved into closely related allopatric species over the last several million years.

ACKNOWLEDGMENTS

In years past this study would not have been possible without an enormous expenditure of time and money. Credit for the use of photographs of the holotypes is given to the Smithsonian Institution's online Invertebrate Zoology Collections Search, the Biodiversity Heritage Library, and the Mollusca Types in Great Britain website. The author thanks Dr. Edward J. Petuch for his guidance and review, as well as Greg Curry (Florida), Kevan Sunderland (Florida), and Jose Bento (Lisbon, Portugal) for freely sharing their knowledge, information, and photographs of these fascinating mollusks. Special thanks are given to Dr. Ellen Strong of the Smithsonian Institution for her extraordinary efforts and excellent macro photography of the type specimens in the USNM illustrated herein, and the National Museums Liverpool for the use of its image of the long lost type of *V. polypleura* Crosse, 1876.

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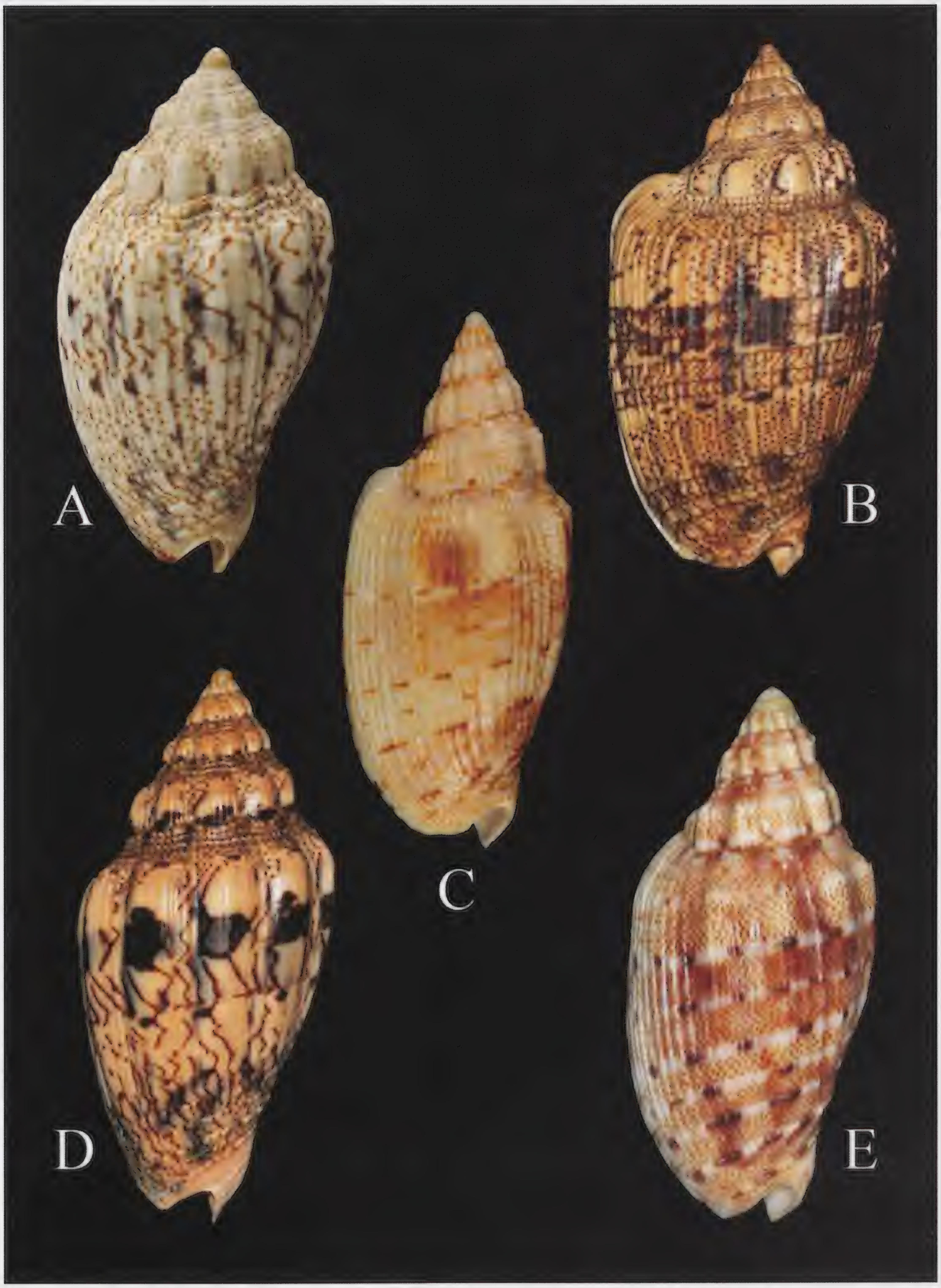

Figure 3. **A** = *V. polypleura* Crosse, 1876, holotype 56 mm; **B** = *V. demarcoi* Olsson, 1965, holotype 84.6 mm; **C** = *V. morrisoni* (Petuch, 1980), holotype 73.4 mm; **D** = *V. garciai* (Petuch, 1981). holotype 63 mm; **E** = *V. harasewychi* (Petuch, 1987), holotype 45 mm. All specimens are shown the same size in this figure for comparison.

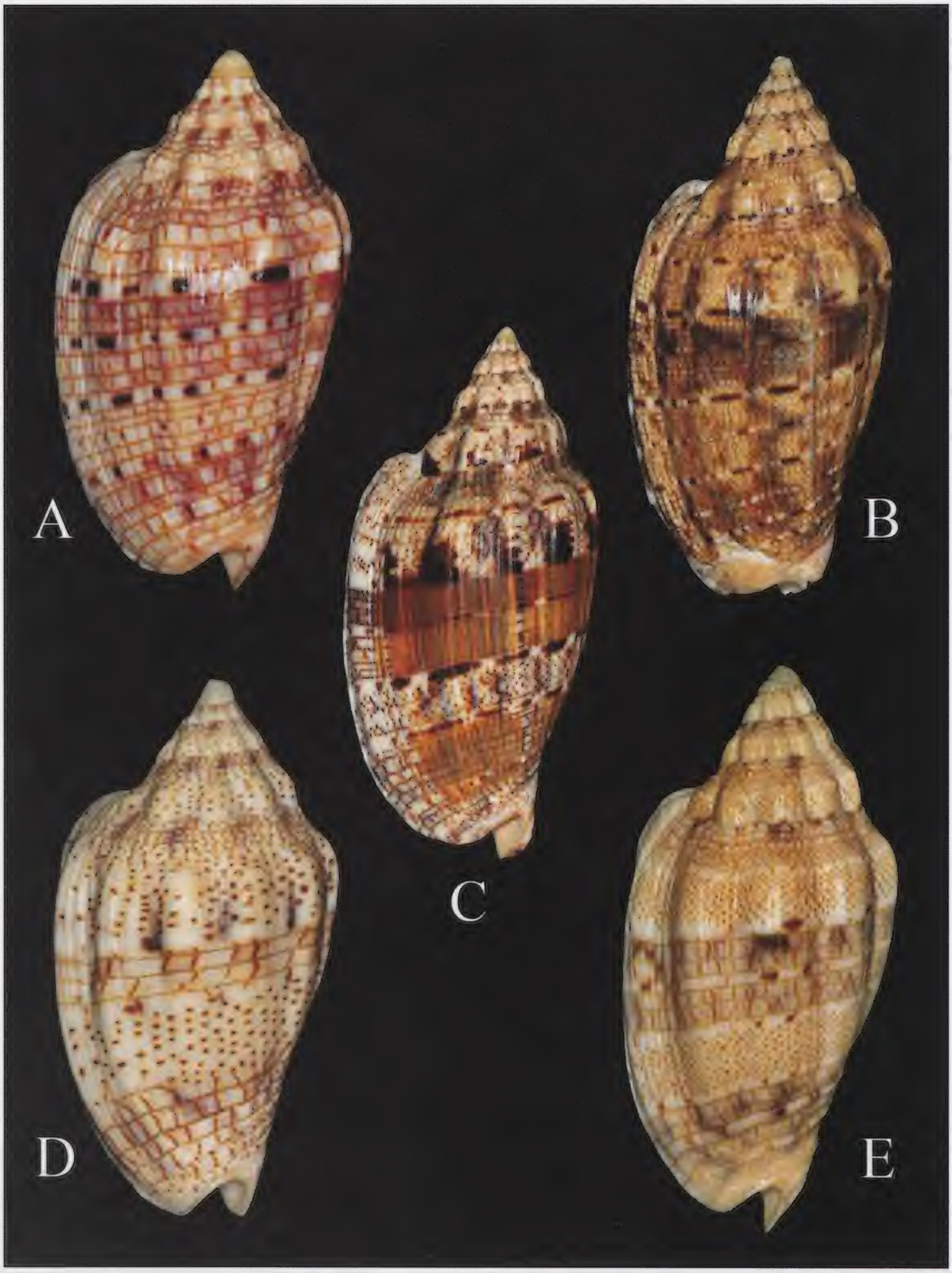

Figure 4. A = *V. kotorai* (Petuch, 1981), holotype 49 mm; **B** = *V. retemirabila* (Petuch, 1981). holotype 75 mm; **C** = *V. hilli* (Petuch, 1987), holotype 88 mm; **D** = *V. sunderlandi* (Petuch, 1987), holotype 53 mm; **E** = *V. ernesti* (Petuch, 1990), holotype 54 mm. All specimens are shown the same size in this figure for comparison.

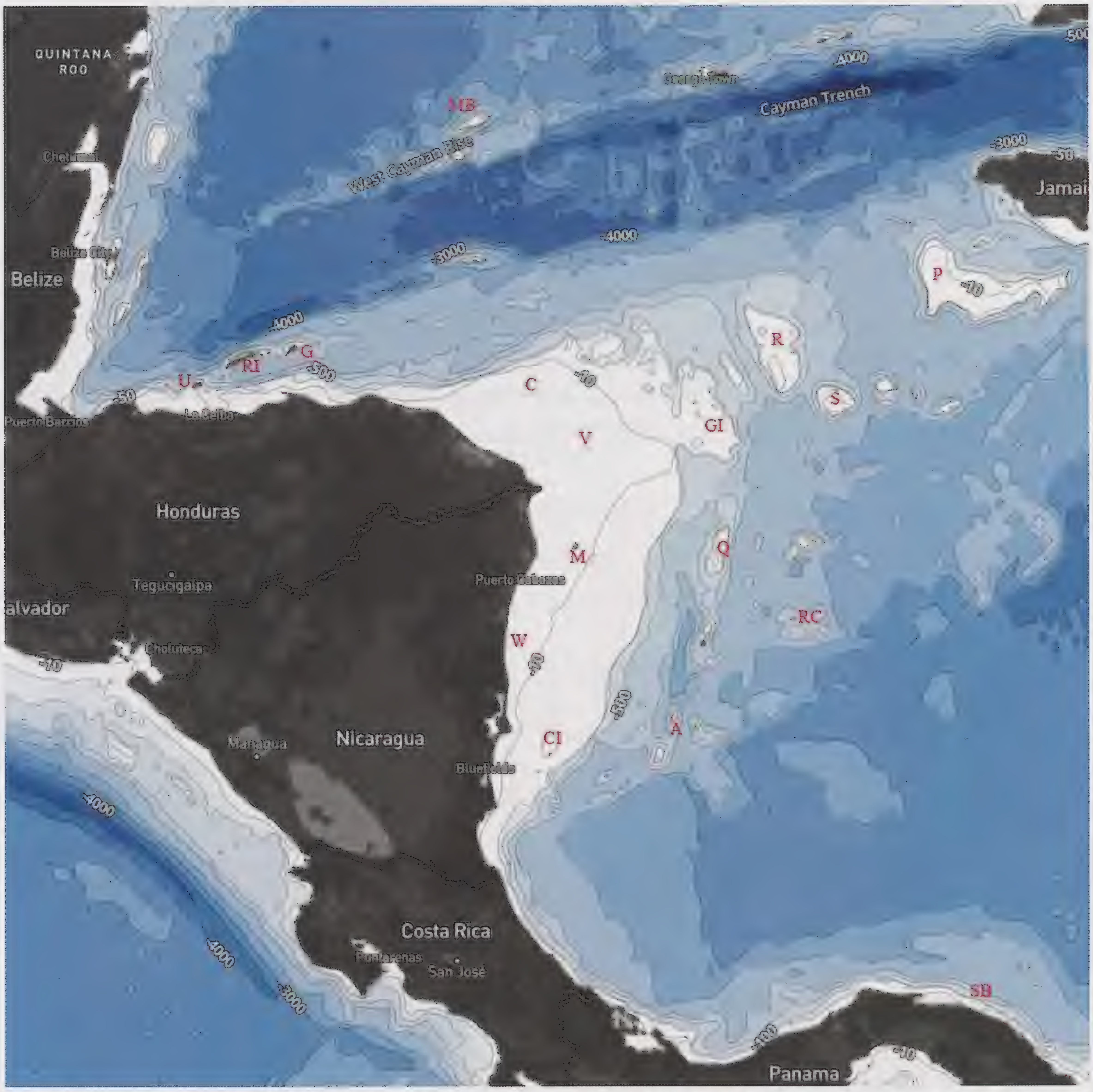

Figure 5. Bathymetric Color Scale Map of the Nicaraguan Subprovince of the Caribbean Province. Depth is noted in meters at contour lines. Some of the important geographic features of the area, north to south, are: **MB** = Misteriosa Bank; **U** = Utila Island; **RI** = Roatan Island; **GI** = Guanaja Island (The Bay Islands); **C** = Caratasca Cay; **V** = Vivorillos Cays; **G** = Gorda Bank; **R** = Rosalind Bank; **S** = Serranilla Bank; **P** = Pedro Bank; **M** = Miskito Cays; **W** = Wawa River mouth; **Q** = Quitasueño Bank; **RC** = Roncador Bank; **A** = Alburquerque Cays; **CI** = Corn Island; **SB** = San Blas Islands. (Adapted from a Topographic Bathymetry / Global Themetic Map, on www.tcarta.com - fair use doctrine claimed.)

Species	Protoconch	Spire	Whorls	Shoulder	Subsutural area	Columella sculpture
polypleura	3 whorls, bulbous, large, tan-brown	High	8-9 axial ribs, rounded	Weak, smooth rounded	Weak, 3-4 coarse large cords	8 major & 3 minor smooth plications
demarcoi	1.5 whorls, bulbous, large, rosy-brown	Slightly elevated	8 smooth axial ribs, rounded	Broad, 8 knobs, rounded	Sharp, 3 coarse large spiral cords	14 smooth plications
morrisoni	3 whorls, Smooth, bulbous, large., salmon-orange	Elevated	7-12 axial ribs, 30+ minor ribs	Angled, w/ blunt knobs	3-4 raised, beaded spiral cords	8-9 major w/ 3-6 minor plications
garciai	3 whorls, glassy. tan	High	10 axial ribs, many minor ribs	Sharply defined, w/ 3 cords	7 lg. beaded cords	9 sharp plications
kotorai	3 whorls, bulbous, large, white	Low	7-10 axial ribs, many minor ribs	Smooth, rounded	3 beaded spiral cords, undulating	12-14 thin plications
retemirabila	3 whorls, glassy, white	High	11 low flat axial ribs	Smooth, rounded	4 wide and raised spiral cords	15 plications, 5 of which are larger
harasewychi	3 whorls, dome shaped, large, white	Average	Thin low axial ribs / grow lines	Indistinct, 8-10 knobs, rounded	2-3 large spiral cords	10-12 thin pustulated pliactions
hilli	2 whorls, cylindrical, flattened top, yellow-salmon	Average	Numerous low axial ribs	10-12 large rounded knobs	4 large raised spiral cords	10-12 major, w/ mid minor plications
sunderlandi	1.5 whorls, flattened Dome shaped, large, white	Low	9 large axial ribs	Rounded, knob-like ribs	Numerous large raised spiral cords	10 major w/ mid minor plications
ernesti	2.5 whorls, dome-like, large, rounded, yellow-gold	Elevated	8-10 axial ribs, many minor ribs	Angled w/ single lg. cord	3 lg. spiral cords, w/ ribletts	11-12 thin plications

Table 1. Comparison of the morphological differences between the ten species in the *Voluta polypleura - demarcoi* complex

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Five New Gastropoda (*Casmaria*, *Sassia*, *Kilburnia*, *Quasimitra* and *Calliostoma*) from the Eastern Seaboard of Southern Africa and a Revision of *Mitra boswellae*

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ABSTRACT Five new gastropods are described from the Eastern Seaboard of Southern Africa. These Molluscs include *Casmaria natalensis* new species (from Kwazulu-Natal, South Africa), *Sassia mozambicana* new species (from Mozambique), *Kilburnia emmae* new species (from Eastern Cape Province, South Africa), *Quasimitra rubrolaterculus* new species (from Kwazulu-Natal, South Africa), and *Calliostoma margaretae* new species (from Kwazulu-Natal, South Africa). The status of *Mitra boswellae* is reviewed.

KEYWORDS *Casmaria, Sassia, Kilburnia, Quasimitra, Mitra, Scabricola, Fasciolariidae,* South Africa, Eastern Cape Province, Kwazulu-Natal, Mozambique

INTRODUCTION

Dredging in new areas at 75 to 100 metres off Southern Natal has brought to light new gastropod species, including an interesting smaller member of the *Cassidae*. Alan Seccombe has considerable experience regarding world *Cassidae*, and this, combined with very useful fresh information and images presented in the recently published "*Cassidae*, An Amazing Family of Seashells", has consolidated thinking regarding the newly described species, *Casmaria natalensis*.

Specimens of a *Sassia* species marked '*cf. nassariformis*' have been taken from off Bazaruto, Mozambique at depths of 320 to 360 metres over a period of time. (Pers. com. J. Rosado). Although initially bearing a resemblance to *S. nassariformis*, there is a consistent difference in size, colour and morphology of these shells that allows for separation from the more southern *nassariformis,* resulting in *Sassia mozambicana* n.sp. being described.

Recently, A. Seccombe has acquired a number of specimens of a member of the *Fasciolariidae* that is currently undescribed. He has known about this species for a number of years having first obtained specimens more than 15 years ago. All shells were dredged in approximately 65 metres depth off Cape St. Francis, in the Southeast Cape area of South Africa. Despite being known about, this species was not depicted in Marais & Kilburn (2010), who discussed and figured the known *Fasciolariidae* occurring in the waters of South Africa, nor was it depicted in Recent Fasciolariidae.

This species, *Kilburnia emmae* n.sp., can only be confused with *Africofusus adamsii* (Küster & Kobelt, 1876), small specimens of which are often caught at the same depth and in the same habitat, and juvenile *Kilburnia scholvieni* (Strebel, 1911). The most similar known species in South African waters in the genus *Kilburnia* is *K. heynemanni* (Dunker, 1870), however, it occurs many hundreds of kilometres to the North, off the Coast of the northern Eastern Cape Province in the region of Coffee Bay.

Snyder, M.A., Vermeij, G.J. & Lyons, W.G., 2012 separated the Fasciolariidae into a number of different genera. The genus into which this species most closely fits is *Kilburnia*, all species of which occur in the same geographical area.

A decade has passed since the comprehensive work on the living South African *Mitridae* by Markus Lussi in Malacologia 62 of 2009. No local activity in this family is noted since then. Over this period, less than a handful of specimens of an attractive, large *Mitra* have been dredged in deep water (100 metres) off Southern Natal. Sufficient specimens were finally obtained to warrant the description of *Quasimitra rubrolaterculus* n.sp.

Further to this, the acquisition of some fine specimens of *Scabricola guttata* taken by SCUBA off Southern Natal, resulted in this species being re-visited in South Africa and the review of *Mitra boswellae*.

A new species of *Calliostoma* from South-eastern Africa is described, together with a comparison of the *Calliostoma* species found in deep water (90 to 120 metres depth) off Kwazulu-Natal South Coast, South Africa.

ABBREVIATIONS

NMSA	KwaZulu-Natal Museum, Pietermaritzburg, South Africa
n. sp.	New species
pers. comm.	Personal communication

SYSTEMATICS

Class: Gastropoda
Subclass: Caenogastropoda
Order: Littorinimorpha
Superfamily: Tonnoidea Suter 1913
Family: Cassidae Latreille, 1825
Subfamily: Phaliinae Beu, 1981

Genus *Casmaria* H & A. Adams, 1853

Casmaria natalensis R. Aiken and
A. Seccombe, new species.
(Figure 1, Plate 1 A-G)

Description. Shells ovate, light-weight, tending towards globose. Size small, 27 to 30 mm, spire pointed, non-varicose. Whorls smooth and glossy, aperture obliquely pyriform, accounting for almost two thirds of the shell length. Parietal shield absent, columellar fold with six sharp lirae. Anterior canal short, outer lip fairly thin, recurved, bearing three to five short, sharp prickles on the lower half thereof. Background colour pale brown, with four spaced radial rows of almost square deep brown blotches. Pale off white subsutural band, interspersed with evenly spaced dark brown almost square blotches. Labial edge marked with dark dashes.

Type and distribution. Type locality of the holotype and paratypes of *C. natalensis* is off southern KwaZulu-Natal, South Africa, dredged in new areas at depths of 75 to 100 metres.

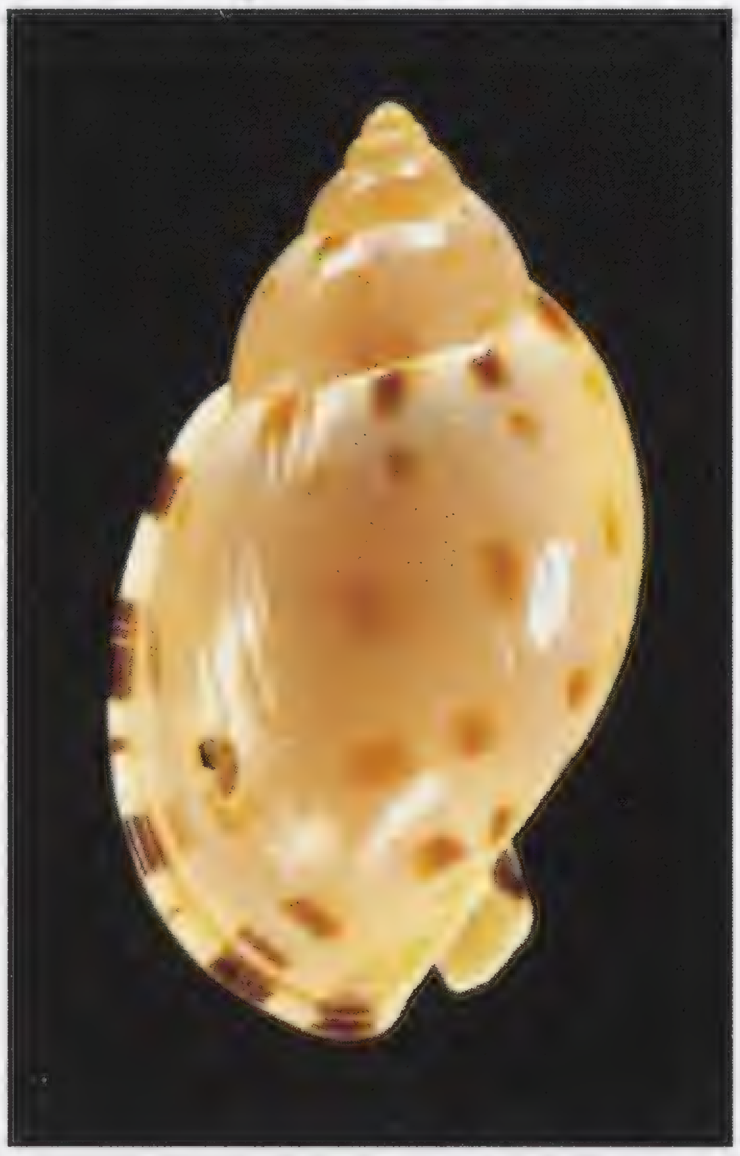

Figure 1. *Casmaria natalensis* R. Aiken and A. Seccombe new species, holotype.

Type specimens.

Holotype:	29.2 x 16.8 mm. (Plate 1.1); in Natal Museum (NMSA), ID No: P1161/T4316.
Paratype 1:	30.0 x 18.0 mm. R. Aiken Collection.
Paratype 2:	29.2 x 17.1 mm. R. Aiken Collection.
Paratype 3:	30.0 x 17.6 mm. R. Aiken Collection.
Paratype 4:	23.6 x 14.0 mm. A. Seccombe Collection.
Paratype 5:	26.8 x 17.0 mm. R. Aiken Collection.
Paratype 6:	34.2 x 18.9 mm. A. Seccombe Collection.
Paratype 7:	30.2 x 18.0 mm. R. Aiken Collection.
Paratype 8:	21.0 x 12.6 mm. A. Seccombe Collection.
Paratype 9:	26.8 x 16.6 mm. R. Aiken Collection.

Etymology. Named for Natal, South Africa, where the species was discovered.

Discussion. This species is found in a similar area to *Semicassis decipiens* (Kilburn, 1980), but differs from the latter by way of smaller size on average, more bulbous shape, and different pattern on the whorl. *Cf.* Plate 1 I-J.

There is an interesting and noteworthy similarity across the oceans, between *Casmaria atlantica* Clench, 1944 (Western Atlantic) [Plate 1 K-L, *Casmaria perryi* (Iredale, 1912) (New Zealand and Easter Island), and *Casmaria cernica* (G. B. Sowerby III, 1888) (China Sea and Philippines) [Plate 1 M-N], of which *C. ponderosa nipponensis* is accepted as a synonym. *Casmaria natalensis* bears a similar resemblance to the above three species, at the low end of their size range. *C. natalensis* potentially fills an ancient ocean gap between the Caribbean and New Zealand.

Class: Gastropoda
Subclass: Caenogastropoda
Order: Littorinimorpha
Superfamily: Tonniodea
Family: Cymatiidae
Genus *Sassia* L.M.D. Bellardi, 1873.

Sassia mozambicana R. Aiken and A. Seccombe, new species

(Figure 2, Plate 2 A-J, Plate 3 A-D)

Description. Shells averaging 49.2 mm, ranging from 45.0 mm to 55.1 mm, shape broadly fusiform, fairly high-spired. Spiral sculpture of eight cords, crossed by axial costae that produce prominent nodules at their intersection. Varices regular, aperture oval, parietal glaze strong, covering a large part of the columellar area. Single, strong posterior notch. Inner labrum has seven denticles, strongest posteriorly. Columella with two strong pleats anteriorly, giving way to more faint plications towards the posterior. Siphonal canal medium sized and recurved. Shell base colour almost white (even in live specimens), with faint sporadic brown markings on the whorl and varices.

Type and distribution. Type locality of the holotype and paratypes of *S. mozambicana* is off Bazaruto, Mozambique, trawled at depths of 320 to 360 metres.

Holotype:	45.2 mm x 23.0 mm (Plate x.1), with operculum. Off Bazaruto, Mozambique. Coll. Natal Museum South Africa (NMSA), ID No: M0261/T4317. Donated by A. Seccombe.
Paratype 1:	48.5 mm x 23.2 mm. Off Bazaruto, Mozambique. R. Aiken Collection.
Paratype 2:	45.0 mm x 21.0 mm. Off Bazaruto, Mozambique. R. Aiken Collection.

Paratype 3: 55.1 mm x 25.1 mm. Off Bazaruto, Mozambique. R. Aiken Collection.
Paratype 4: On *X. pallidula*. broken attachment. Off Bazaruto, Mozambique. R. Aiken Collection.
Paratype 5: 53.0 mm x 23.8 mm. Off Bazaruto, Mozambique. A. Seccombe Collection.
Paratype 6: 48.0 mm x 22.9 mm. Off Bazaruto, Mozambique. A. Seccombe Collection.
Paratype 7: 50.2 mm x 22.8 mm. Off Bazaruto, Mozambique. A. Seccombe Collection.

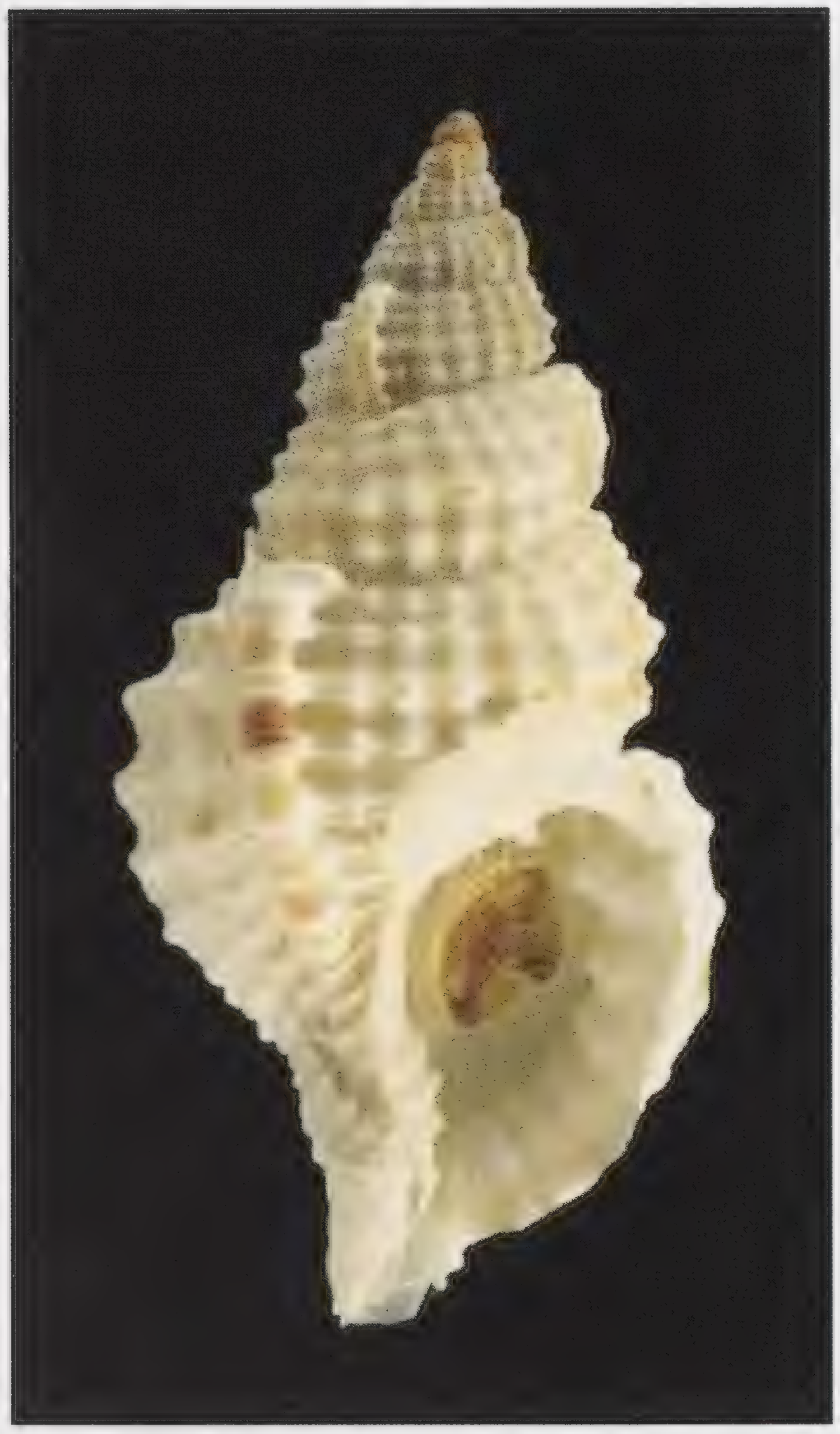

Figure 2. *Sassia mozambicana* R. Aiken and A. Seccombe new species, holotype.

Etymology. Named for Mozambique, where it appears to be endemic.

Discussion. Specimens of a *Sassia* species marked '*cf. nassariformis*' have been taken from deep water off Bazaruto, Mozambique at depths of 320 to 360 metres over time. (Pers. com. J. Rosado). Although, initially bearing a resemblance to *S. nassariformis*, there is a consistent difference in size, colour and morphology of these shells that allows for separation from the more southern *S. nassariformis*.

Sassia mozambicana new species, can be distinguished from its closest congener, *S. nassariformis* (Plate 3 E-L), by its constant pale white colour, broader morphology, more northern locale, larger shells on average, and deep habitat. Specimens attached to *Xenophora pallidula* verify this.

Class: Gastropoda
Subclass: Caenogastropoda
Order: Neogastropoda
Superfamily: Buccinoidea
Family: Fasciolariidae
Subfamily: Fasciolariinae
Genus *Kilburnia* Snyder, Vermeij & Lyons, 2012

Kilburnia emmae A. Seccombe & R. Aiken, new species

(Figure 3, Plate 4 A-L, Plate 5 A-B)

Description. Shell fusiform, with high spire and long siphonal canal; small for the genus, the size of adult shells ranging from 55 to 64 mm; protoconch papilliform. Teleoconch whorls 6, shouldered; shoulder slope broad, concave, summit adpressed to preceding whorl; sutures shallow. Axial sculpture of very low, rounded folds. Spiral sculpture of rather strong, rounded ridges bearing prominent nodules, 2 rows on spire whorls, last whorl with 10 to 11. Nodules strongest on shoulder ridge, becoming smaller anteriorly, *ca.* 11 on last whorl. Spiral interspaces and shoulder slope with smooth microscopic spiral treads, middle one often stronger than the rest. Aperture oval; outer lip thick, pinched in anteriorly, with sharp crenulated edge. Labral teeth, often arranged in pairs, formed by thin lirae reaching deep into interior of shell. Siphonal canal narrow, open, entrance fold prominent, keel-like. Columella evenly concave, with 1 columellar fold; parietal ridge prominent.

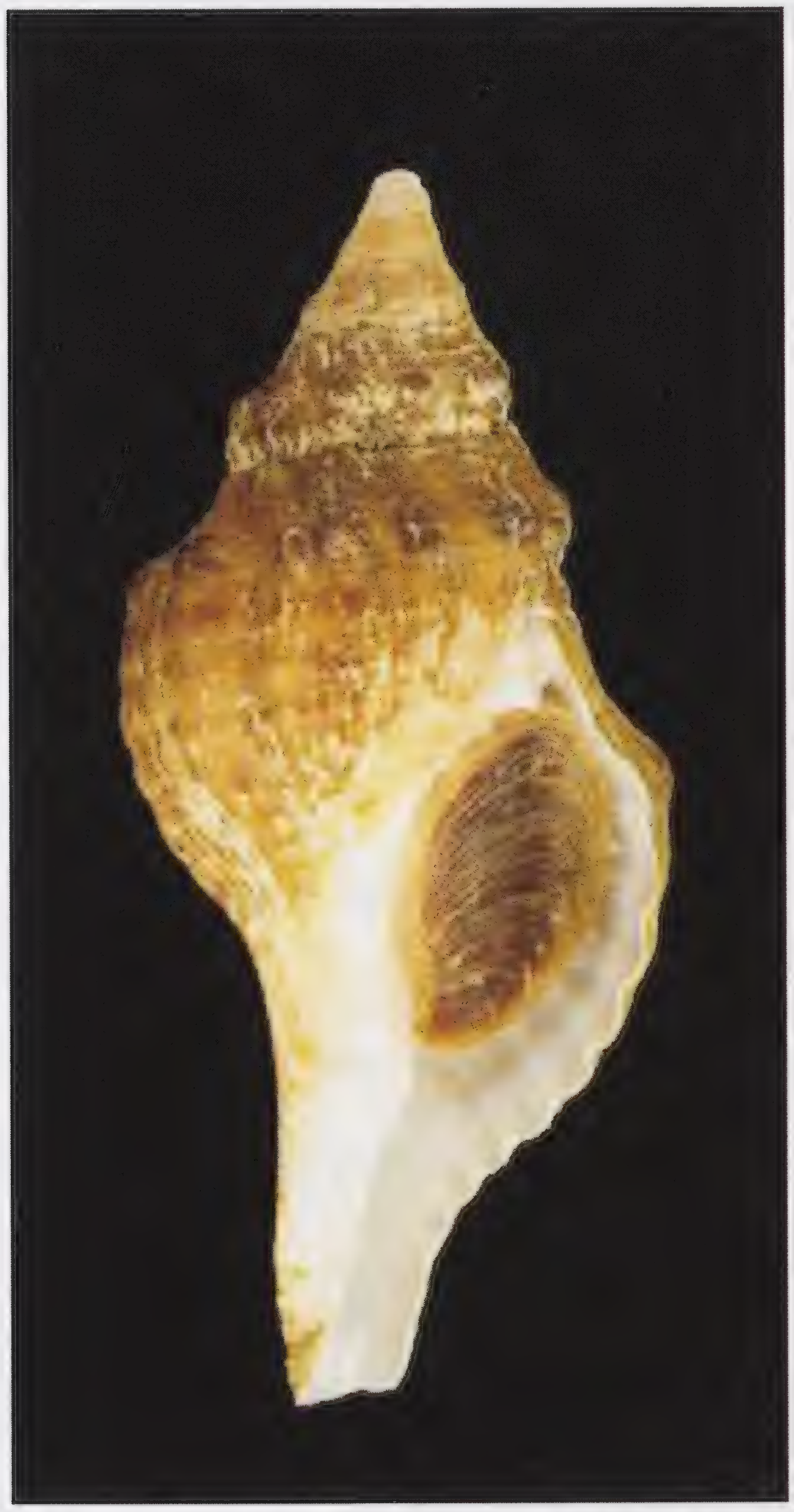

Figure 3. *Kilburnia emmae* A.Seccombe and R. Aiken, new species, paratype 2.

Dimensions: H 56.29 mm W 24.16 mm (holotype); H 64.80 mm x W 26.90 mm (largest paratype).

Shell colour dull, dirty white; nodules dark brown with white interspaces; shoulder slope with faint, intermittent spiral streaks of brown; protoconch, columella and aperture white. Periostracum brown, smooth and thin, shell pattern visible underneath.

Operculum oval-elongate, tapered bluntly anteriorly, dark brown and lighter around the edges, outer surface smooth with numerous growth increments arranged in concentric arcs.

Animal carmine red in colour.

Type and distribution. Type locality of the Holotype and paratypes of *K. emmae* is off Cape St. Francis, in the Southeast Cape area, South Africa, *ca.* 65 metres.

Holotype:	56.29 mm. Off Cape St. Francis, in the Southeast Cape area of South Africa, *ca.* 65 metres. NMSA P1163/T4318.
Paratype 1:	55.46 mm. Collection A. Seccombe.
Paratype 2:	64.80 mm. Collection A. Seccombe.
Paratype 3:	60.07 mm. Collection A. Seccombe.
Paratype 4:	58.78 mm. Collection A. Seccombe.
Paratype 5:	57.44 mm. Collection R. Aiken.
Paratype 6:	52.30 mm. Collection of Alwyn & Johan Marais.
Paratype 7:	51.76 mm. Collection A. Seccombe.
Paratype 8:	50.20 mm. Collection A. Seccombe.
Paratype 9:	45.33 mm. Collection A. Seccombe.
Paratype 10:	47.90 mm. Collection A. Seccombe.

Paratype 11: 48.93 mm. Collection A. Seccombe.

Paratype 12: 45.90 mm. Aiken Collection.

Distribution. Known only from type locality.

Etymology. The species is named after Emma Grobler, step daughter of Alan Seccombe.

Discussion. *Kilburnia emmae* here described is known from 20 specimens. The specimens were dredged between 2011 and 2014; 16 were live-collected and still retain operculae. Depths of collection, recorded for all specimens, indicate a range of 60 to 65 metres. The specimens were compared with *K. heynemanni* (Dunker, 1876), a shallow water species found in 15 to 30 metres off the northern coast of the Eastern Cape (Coffee Bay is the best known locality for this species), 2 specimens of juvenile *K. scholvieni* (Strebel, 1911) and with 5 specimens of *Africofusus adamsii* (Kobelt, 1880) from the same area and depth.

Kilburnia emmae is similar in general shape to *K. heynemanni* (Plate 5 G-H), but considerably smaller (45 mm to 65 mm compared to greater than 80 mm) less strongly shouldered, the spiral ridges on the last whorl are relatively much stronger than those on *K. heynemanni* and the nodules are not only restricted to the shoulder ridge of each whorl, but occur on all ridges. Furthermore, the labral teeth of *K. emmae* are relatively stronger, the protoconch much larger and the nodules are dark brown instead of pale brown to cream in *K. heynemanni.*

Africofusus adamsii (Plate 5 C-D) is superficially remarkably similar to *K. emmae*, but on closer inspection can readily be separated from the latter. The spire tapers to a fine point with a relatively small protoconch. The shell is much wider, the siphonal canal slender but longer, usually 33 to 40 percent of the shell length. It has no parietal ridge nor columellar folds, however, a false umbilicus is present. The operculum is thin and yellow/orange-brown. Although the specimens studied were in the same size range as *K. emmae*, generally speaking *Africofusus adamsii* is a much larger shell and occurs at much greater depths.

Juvenile *K. scholvieni* (Plate 5 E-F) also appear similar primarily due to the dark shoulder knobs and protoconch. However, the *K. emmae* can be distinguished by the more strongly ribbed and patterned body whorl, and shorter, straight siphonal canal, which is white ventrally. Like *A. adamsii, K. scholvieni* in its adult form is a substantially larger shell and occurs at much greater depths.

Class: Gastropoda
Subclass: Caenogastropoda
Order: Neogastropoda
Superfamily: Mitroidea
Family: Mitridae
Subfamily: Mitrinae
Genus *Quasimitra* Fedosov, Herrmann, Kantor & Bouchet, 2018

Quasimitra rubrolaterculus R. Aiken & A. Seccombe, new species.

(Figure 4, Plate 6 A-H, Plate 7 A-E)

Description. Shells relatively large, narrow, pointed, and of medium build. Average size 67 mm, ranging from 63.4 mm to 72.9 mm. Whorls weakly convex to straight-sided, suture with narrow ramp. Columellar plications oblique, numbering four, strongest posteriorly. Sculpture of intermittently pitted spiral grooves. Outer lip cream and crenulate.

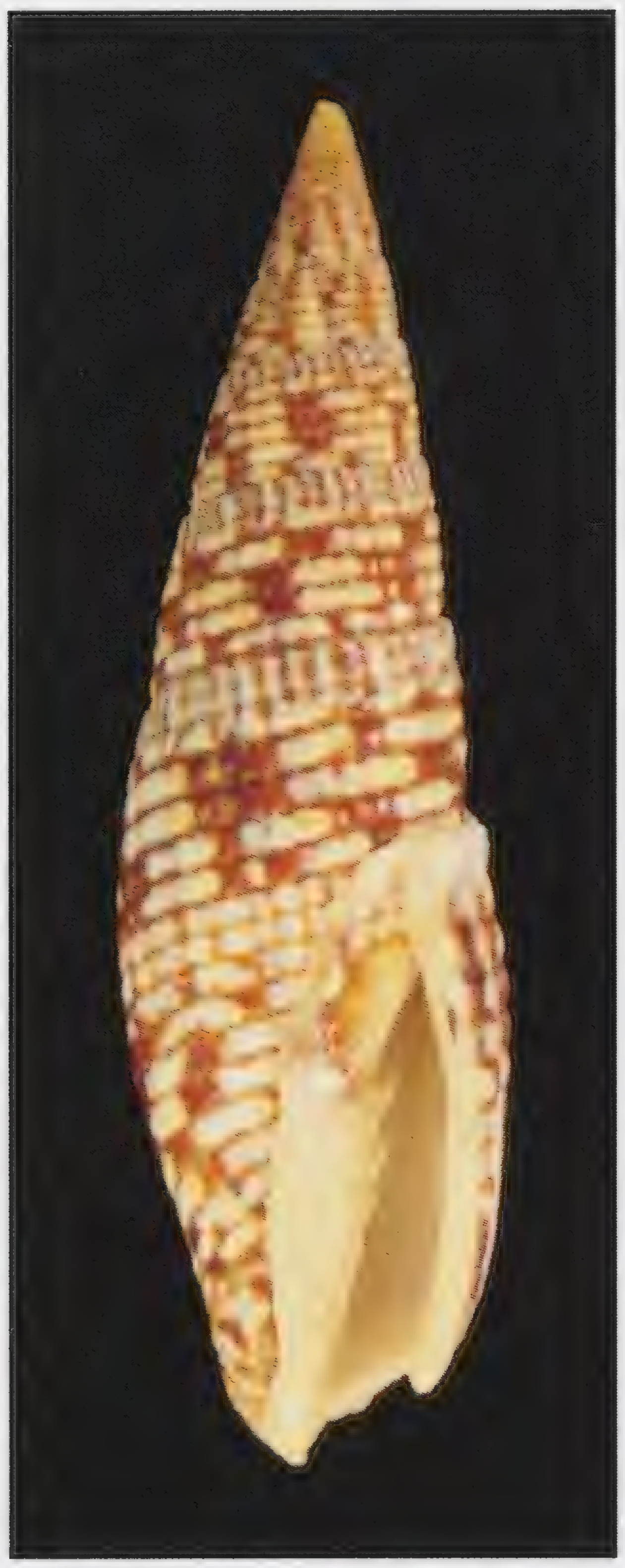

Figure 4. *Quasimitra rubrolaterculus* R. Aiken and A. Seccombe new species, holotype.

Colour brick-red and white, shown as fairly equal radial dashes. Subsutural pattern of a fairly broad band of indented axial white dashes, each separated by a thin red axial dash. Columellar callous strong, particularly anteriorly.

Type and distribution. Type locality of the holotype and paratypes of *Q. rubrolaterculus* is off Southern Kwazulu-Natal, South Africa. Dredged at 100 metres depth.

Holotype:	63.4 x 18.0 mm. Collection NMSA P1164/T4319. Donated to the Natal Museum by A. Seccombe.
Paratype 1:	72.9 x 18.8 mm. Collection A. Seccombe.
Paratype 2:	69.1 x 18.0 mm. Collection R. Aiken.
Paratype 3:	64.0 x 17.9 mm. Collection R. Aiken.

Etymology. Rubro: red, and laterculus: brickwork. Latin combination for the whorl pattern of this species.

Discussion. This species has affinities with two congeners, *Quasimitra rinaldii* (H. Turner, 1993) and *Quasimitra sanguinolenta* (Lamarck, 1811). All three are found off the East coast of Africa. *Q. rinaldii* is not quite as large, slightly broader, and has much smoother whorls, and a somewhat different pattern of red and white "bricks". *Quasimitra sanguinolenta* is a much smaller species, often half the size, stocky, with broad, more squat, somewhat oval profile, stepped sides, stronger sutural channel, and is from a shallower habitat. The sub-sutural band is much thinner, consisting of a row of cream coloured beads set on a red background. The 51.3 mm shell illustrated by Robin & Martin in their Mitridae, is *Q. rubrolaterculus*, noting the axially broad subsutural band. See Plate 7 F-J for comparison.

Class: Gastropoda
Subclass: Caenogastropoda
Order: Neogastropoda
Superfamily: Mitroidea
Family: Mitridae
Subfamily: Imbricariinae
Genus *Scabricola* Swainson, 1840

Mitra boswellae (Cate, 1964)
stat. rev.
(Figures 5-6, Plate 8 E-K)

Discussion. Since the description of *Mitra guttata* by Swainson as far back as 1824, there has been a paucity of information and discoveries of this species over the last 195 years. It is an elusive, little known Mitre, from diverse localities including Madagascar, Reunion, Arabian Gulf, Sri Lanka, Andaman, Oman, Somalia, Mozambique and South Africa. Such was the lack of information on *guttata*, that when J. Cate described *Mitra boswellae* in 1964 after much cogitation, the only species he used for comparison were *M. nubila, M. nebulosa* and *M. brettinghami*.

It is of interest that the comprehensive 1980 work of Pechar, Prior and Parkinson, Mitre Shells from the Pacific and Indian Oceans, covers some 270 species, but they make no mention of *M. guttata*. The description of *M. boswellae* based on a single specimen was bold indeed, notwithstanding the fact that said specimen had been obtained by Helen Boswell from "the *boats in Durban*", now recognized as very inaccurate locality data. Boswell, for all her considerable conchological knowledge, had no idea of the existence of the close congener to her specimen, *M. guttata*. (See Plate 8 A-I)

In more recent times, *M. boswellae* was synonymized with *M. guttata* based on relative perceived similarities between them, but this was based on a notable lack of material, clouding the synonymy. Four South African collectors now have sufficient combined material of '*guttata*' from Kwazulu-Natal, to enable the authors a closer look at the status of *M. boswellae*. Cate's image in The Veliger of the very large sized holotype is clear enough for one to see salient features of *M. boswellae* that afford the realization that this rare *Mitra* is in fact different from *M. guttata* (see Figure 5 below) and is supported by two very pertinent comments made by Cate in his description of *M. boswellae*: "Shell large (70.5 mm), smooth" ...and... "spiral punctations obsolete on last three whorls except immediately below the suture"...enough material is now available to compare *M. boswellae* with *M. guttata. Mitra boswellae* is definitely a larger species on average, often with a much broader profile. The whorls of *M. boswellae* are conspicuously smooth, unlike most *Scabricola*.

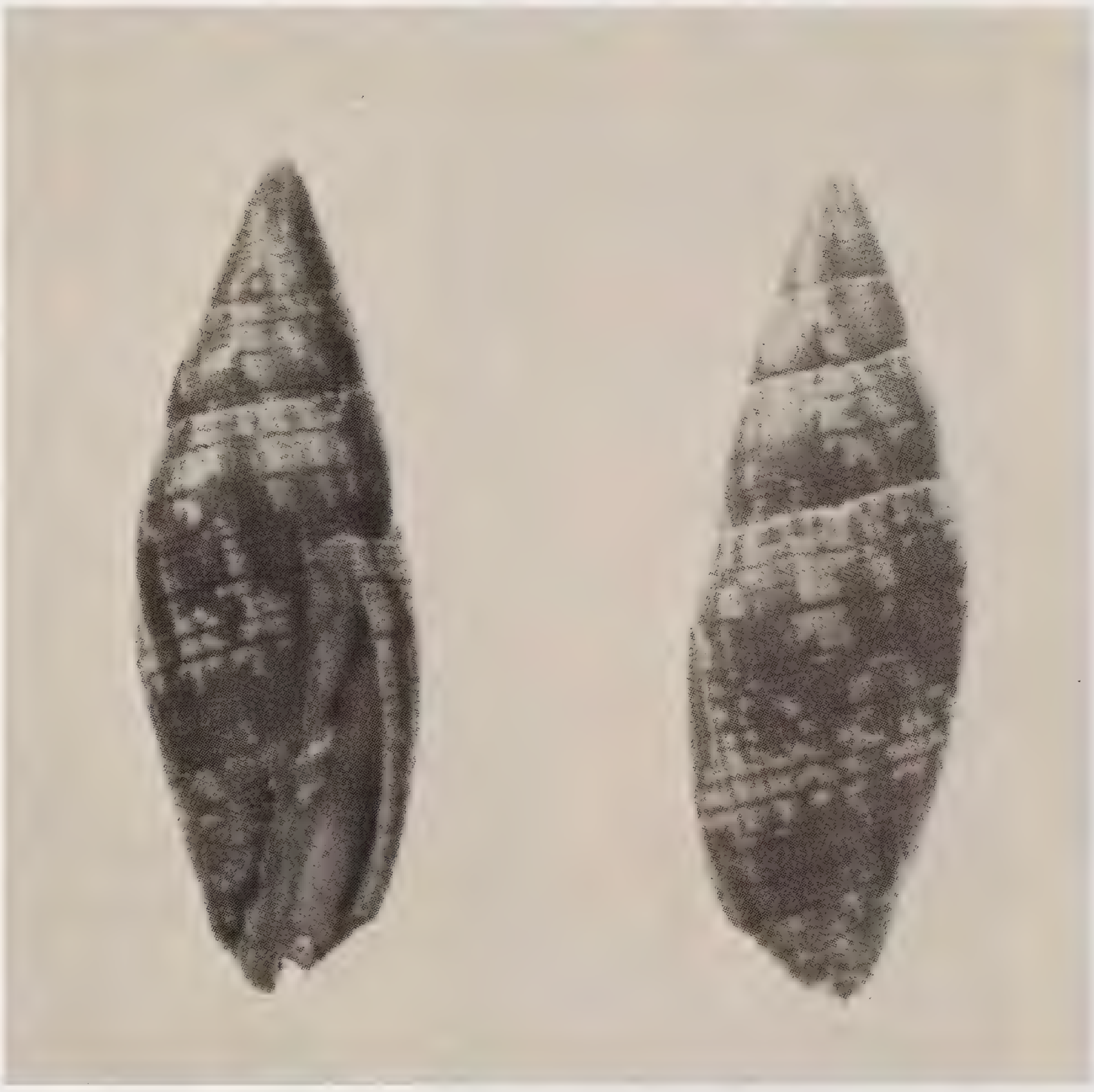

Figure 5. Holotype *Mitra boswellae* Cate, 1964 (70.5 x 24.1 mm). A New Species of *Mitra* from the Western Indian Ocean. 1964. The Veliger 6(4):219-220: Plate 28.

It is notable that the pattern of narrow brown radial lines on the whorl is not pitted, unlike the strong radial pitted grooves of *M. guttata*, raising the question as to whether this species even falls into the Genus *Scabricola*. These surface brown lines on the whorl of *M. boswellae* are spaced noticeably further apart than the pitted grooves of *M. guttata* in all shells of *M. boswellae* examined. Therefore, *M. boswellae* is reinstated as a full species based on these new observations. This species was collected in the Richards Bay harbour dredgings (around ten specimens), and the assumption was then made that the shells were worn smooth. Figure 6 showing live taken specimens, is proof of the fact that the whorl is not worn at all. The doubts expressed by some researchers regarding whether the holotype was *ex pisce* are possibly valid.

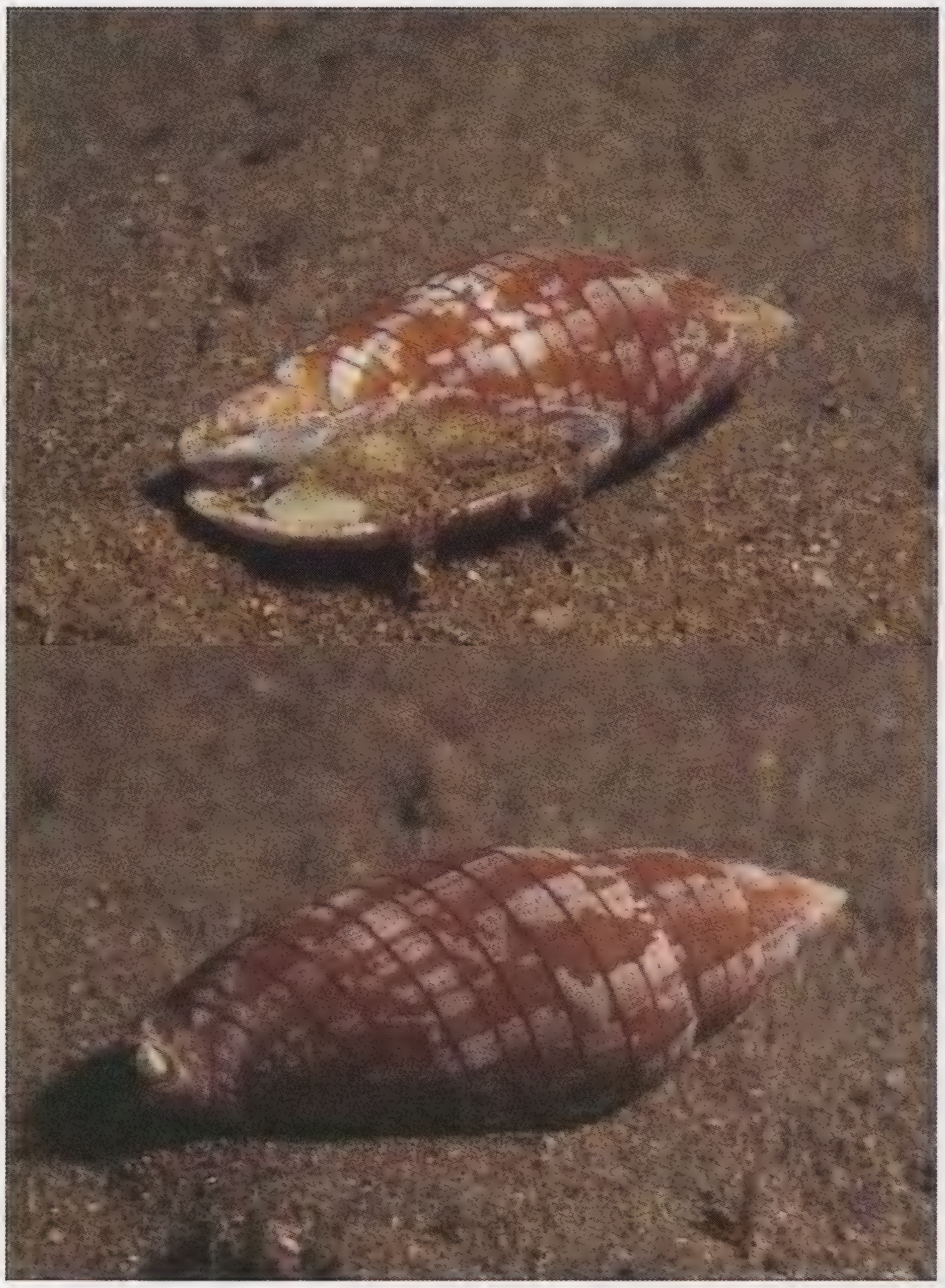

Figure 6. Photographs of the living *Mitra boswellae* Cate, 1964, photographed by Valda Fraser during March 2007.

Class: Gastropoda
Subclass: Caenogastropoda
Order: Neogastropoda
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Family: Mitridae
Subfamily: Mitrinae
Genus *Quasimitra* Fedosov, Herrmann, Kantor & Bouchet, 2018

Calliostoma margaretae A. Seccombe & R. Aiken, new species
(Figure 7, Plate 9 A-I, Plate 10 A)

Description. Shell reaching 22.4 mm in height. Conical shape with high tapering spire. White/cream in colour with purple apex, cream protoconch and irregular red/brown markings on body and earlier whorls (absent in paratype 4). Height to width ratio 1.11:1.23. Base convex with a very small umbilicus the size of a pin hole. Subsutural band absent, shallow spiral ribs on body whorl and spire, faintly pustulose bands. Spire with raised bumps above the suture, and forming a peripheral keel on the body whorl.

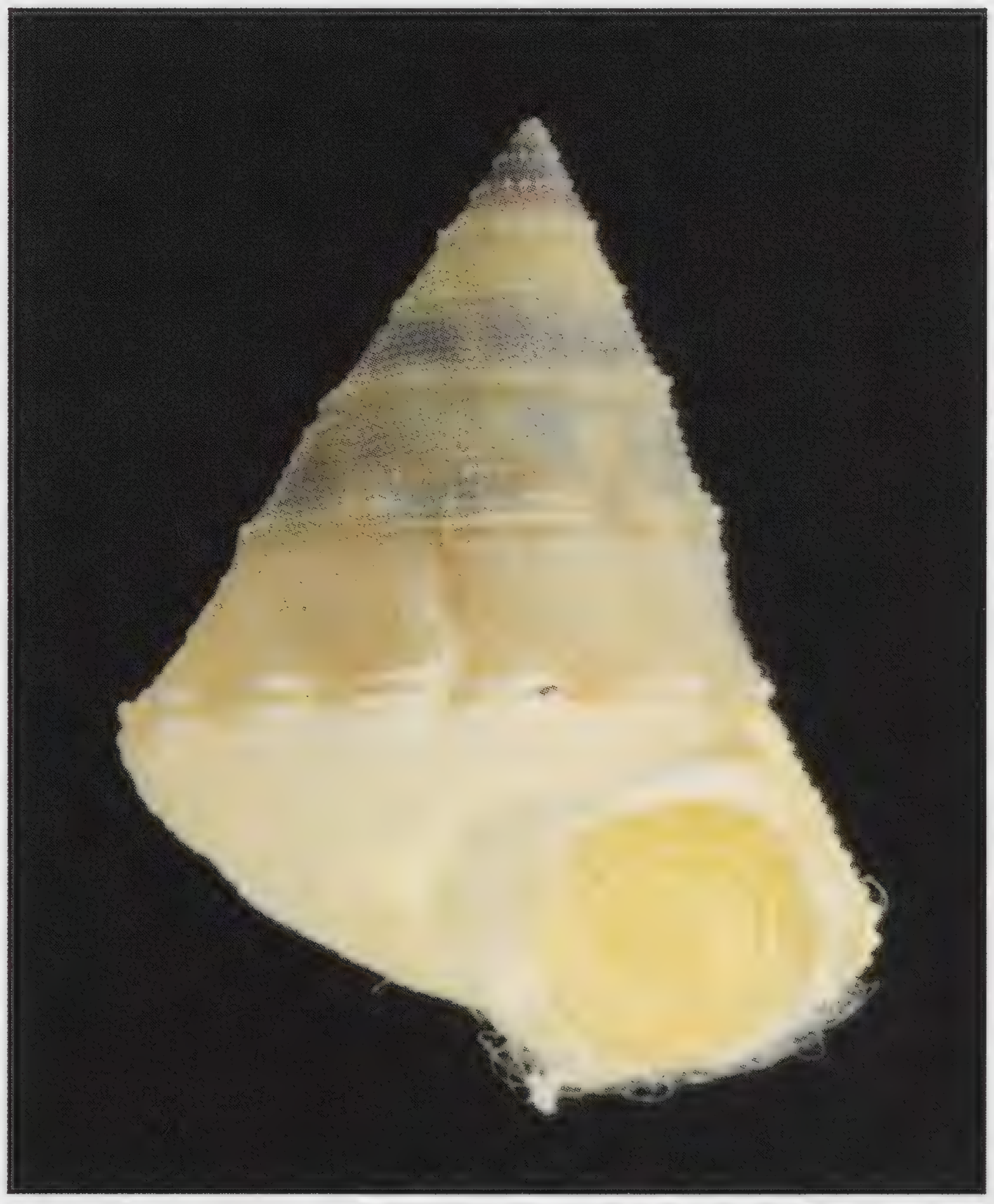

Figure 7. *Calliostoma margaretae* A. Seccombe & R. Aiken new species, holotype.

Type and distribution. Type locality is South Africa, Natal South Coast, off Hibberdene in 94 to 102 metres depth on low profile reef. One specimen collected *ex pisces* (Red Fish) off Richards Bay, Natal North Coast, South Africa (Collection: A. Seccombe)

Holotype:	16.3 mm × 14.8 mm. In collection Natal Museum South Africa, P1165/T4320.
Paratype 1:	20.2 mm x 16.5 mm. A. Seccombe Collection.
Paratype 2:	20.8 mm x 16.8 mm. A. Seccombe Collection.

Paratype 3:	22.4 mm x 19.6 mm. A. Seccombe Collection.
Paratype 4:	21.0 mm x 17.7 mm. A. Seccombe Collection.

Etymology. This species is named in honour of Mrs. Margaret Seccombe, mother of A. Seccombe, who encouraged and developed his interest in natural history from a very early age.

Discussion. *Calliostoma margaretae* resembles *Calliostoma layardi* G.B. Sowerby III, 1897 (Plate 10 D), and can only be confused with this species. *C. margaretae* has a greater height to width ratio (exceeds 1.1:1 and adult shells are closer to 1.2:1, whereas *C. layardi* is usually below 1.1:1. *Calliostoma layardi* is darker brown (although white shells occur) and has prominent sharp knobs on each whorl just above the suture and forming a peripheral keel on the body whorl, as opposed to smother bumps in *C. margaretae* which create an undulating effect. *C. layardi* has deeper spiral ribs and noticeable subsutural band (not present in *C. margaretae*) on the body whorl and spire. The umbilicus in *C. layardi* is wholly or partially occluded.

Calliostoma iridescens G.B. Sowerby III, 1903 has no knobs or bumps on the body whorl or spire, a wider umbilicus and no purple colour on the tip of the spire. *Tristichotrochus crossleyae* (E. A. Smith, 1910) is smaller (max. height around 14 mm) has no umbilicus. Knobs and bumps are absent in both *Calliostoma aikeni* Lussi, 2014 and *Calliostoma africanum* Bartsch, 1915. (see Plate 10, images B-E for comparison)

ACKNOWLEDGEMENTS

Jose Rosado, for bringing our attention to the *S. nassariformis* species; Linda Davis, Collections Manager, Mollusca at the Natal Museum, Pietermaritzburg for supplying accession numbers and Mark Page for photography and document preparation. Philip Jooste provided most specimens of *Kilburnia emmae* and *Fusinus ocelliferus adamsii* that were examined for this study, with Roy Aiken providing the enthusiasm and encouragement to put pen to paper and Alwyn and Johan Marais read an early and later drafts of the manuscript. All are thanked for their assistance. Valda Fraser for the provision of photographs of a live *M. boswellae*.

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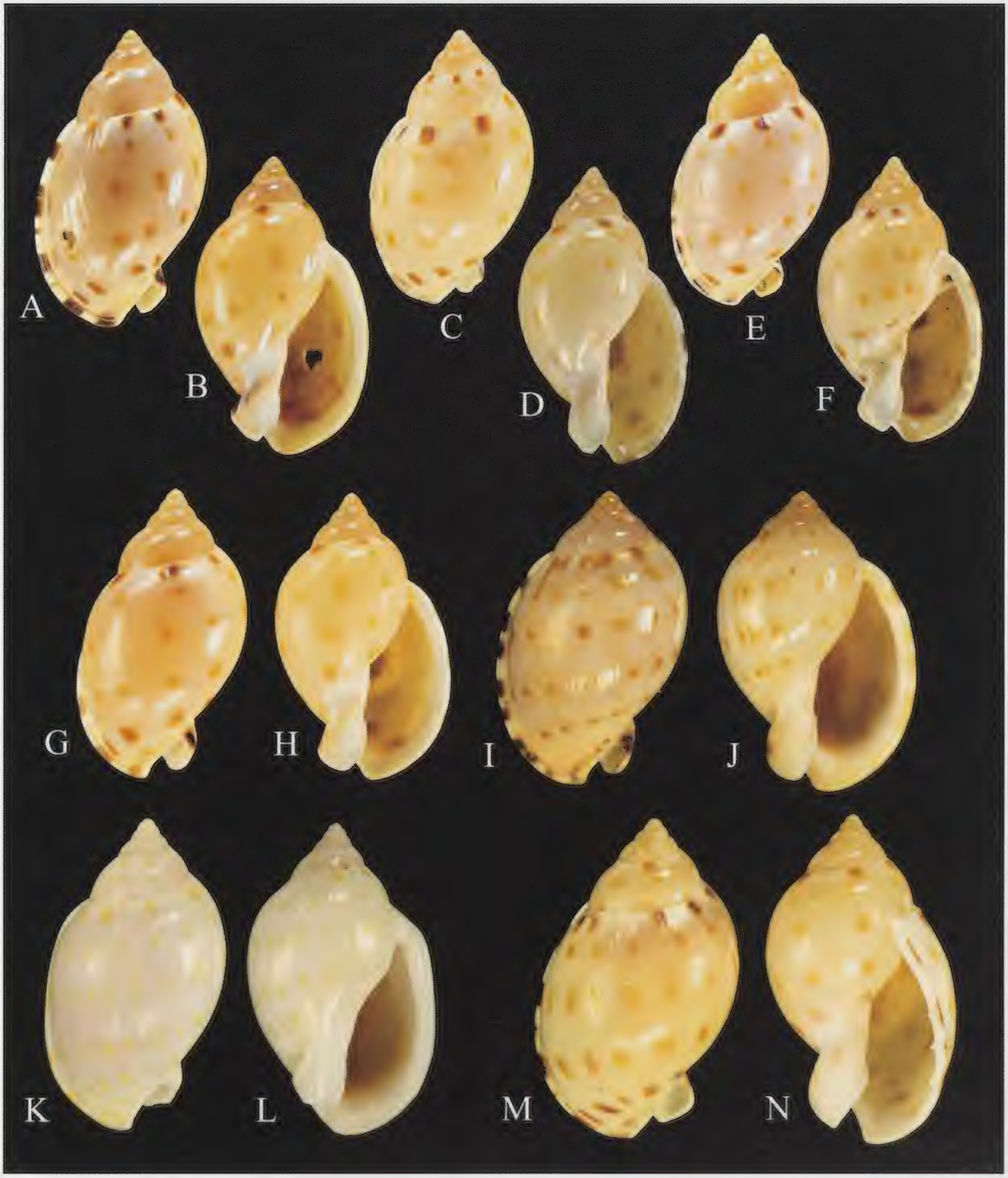

Plate 1. Figures: **A-B** = *Casmaria natalensis* new species (29.2 x 16.8 mm) – Holotype; NMSA Collection, ID No: P1161/T4316, off Southern KwaZulu-Natal, dredged 75 to 100 m. **C-D** = *Casmaria natalensis* new species (30.0 x 18.0 mm) – Paratype 1; off Southern KwaZulu-Natal, dredged 75 to 100 m; Aiken Collection. **E-F** = *Casmaria natalensis* new species (29.2 x 17.1 mm) – Paratype 2; off Southern KwaZulu-Natal, dredged 75 to 100 m; Aiken Collection. **G-H** = *Casmaria natalensis* new species (23.6 x 14.0 mm) – Paratype 4; off Southern KwaZulu-Natal, dredged 75 to 100 m; Seccombe Collection. **I-J** = *Semicassis decipiens* (Kilburn, 1980) (22.2 mm); Off Pumula, Kwazulu-Natal, South Africa; Seccombe collection. **K-L** = *Casmaria atlantica* Clench, 1944 (28.9 mm), Western Atlantic; Seccombe collection. **M-N** = *Casmaria cernica* (G. B. Sowerby III, 1888) (30.1 mm), China Sea; Seccombe collection.

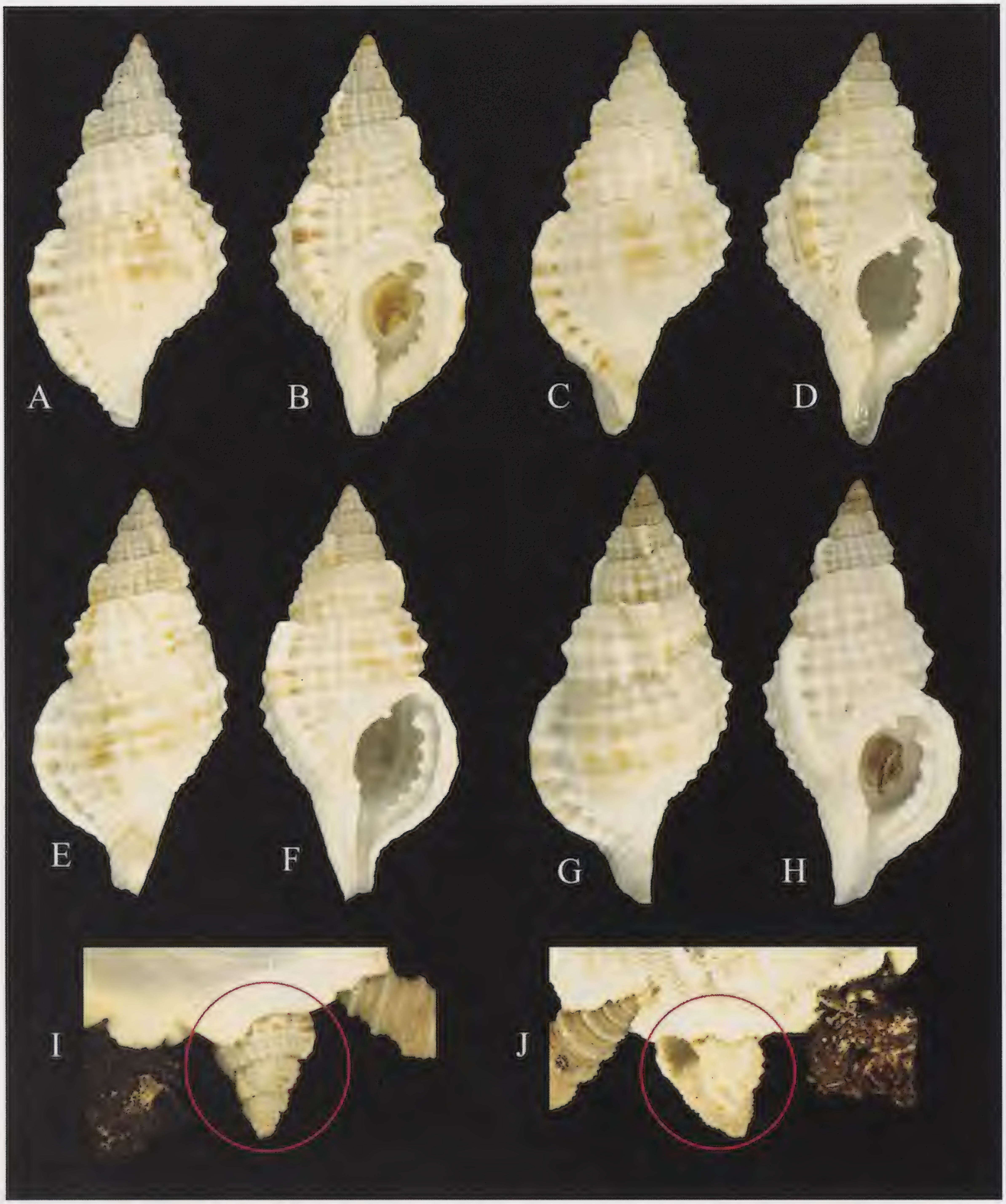

Plate 2. Figures: **A-B** = *Sassia mozambicana* new species (45.2 x 23.0 mm) – Holotype; NMSA Collection, ID No: M0261/T4317, Off Bazaruto, Mozambique, dredged 320 to 360 m. **C-D** = *Sassia mozambicana* new species (48.5 x 23.2 mm) – Paratype 1; Off Bazaruto, Mozambique, dredged 320 to 360 m; Aiken Collection. **E-F** = *Sassia mozambicana* new species (45.0 x 21.0 mm) – Paratype 2; Off Bazaruto, Mozambique, dredged 320 to 360 m; Aiken Collection. **G-H** = *Sassia mozambicana* new species (53.0 x 23.8 mm) – Paratype 5; Off Bazaruto, Mozambique, dredged 320 to 360 m; Seccombe Collection. **I-J** = *Sassia mozambicana* new species – Paratype 4; On *Xenophora pallidula*, Off Bazaruto, Mozambique, dredged 320 to 360 m; Aiken Collection.

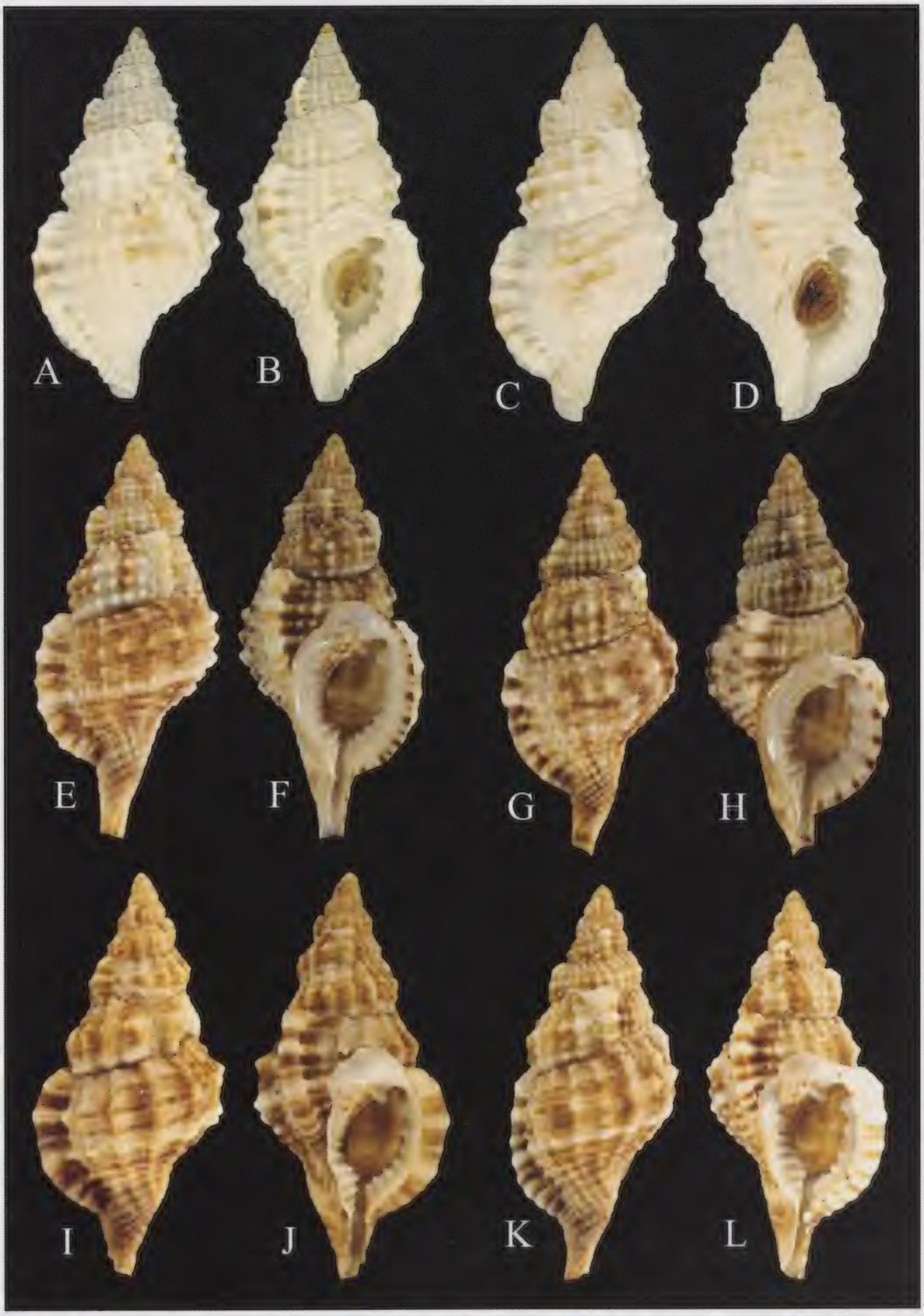

Plate 3. Figures: **A-B** = *Sassia mozambicana* new species (45.2 x 23.0 mm) – Holotype; NMSA Collection, ID No: M0261/T4317, Off Bazaruto, Mozambique, dredged 320 to 360 m. **C-D** = *Sassia mozambicana* new species (50.2 x 22.8 mm) – Paratype 7; Off Bazaruto, Mozambique, dredged 320 to 360 m; Seccombe Collection. **E-F** = *Sassia nassariformis* (G. B. Sowerby III, 1902) (47.3 x 21.2 mm), Off Southern Kwazulu-Natal; Aiken Collection. **G-H** = *Sassia nassariformis* (G. B. Sowerby III, 1902) 48.1 x 21.4 mm), Off Southern Kwazulu-Natal; Aiken Collection. **I-J** = *Sassia nassariformis* (G. B. Sowerby III, 1902) (43.4 x 20.3 mm), Off Southern Kwazulu-Natal; Aiken Collection. **K-L** = *Sassia nassariformis* (G. B. Sowerby III, 1902) (38.1 x 17.6 mm), Off Southern Kwazulu-Natal; Aiken Collection.

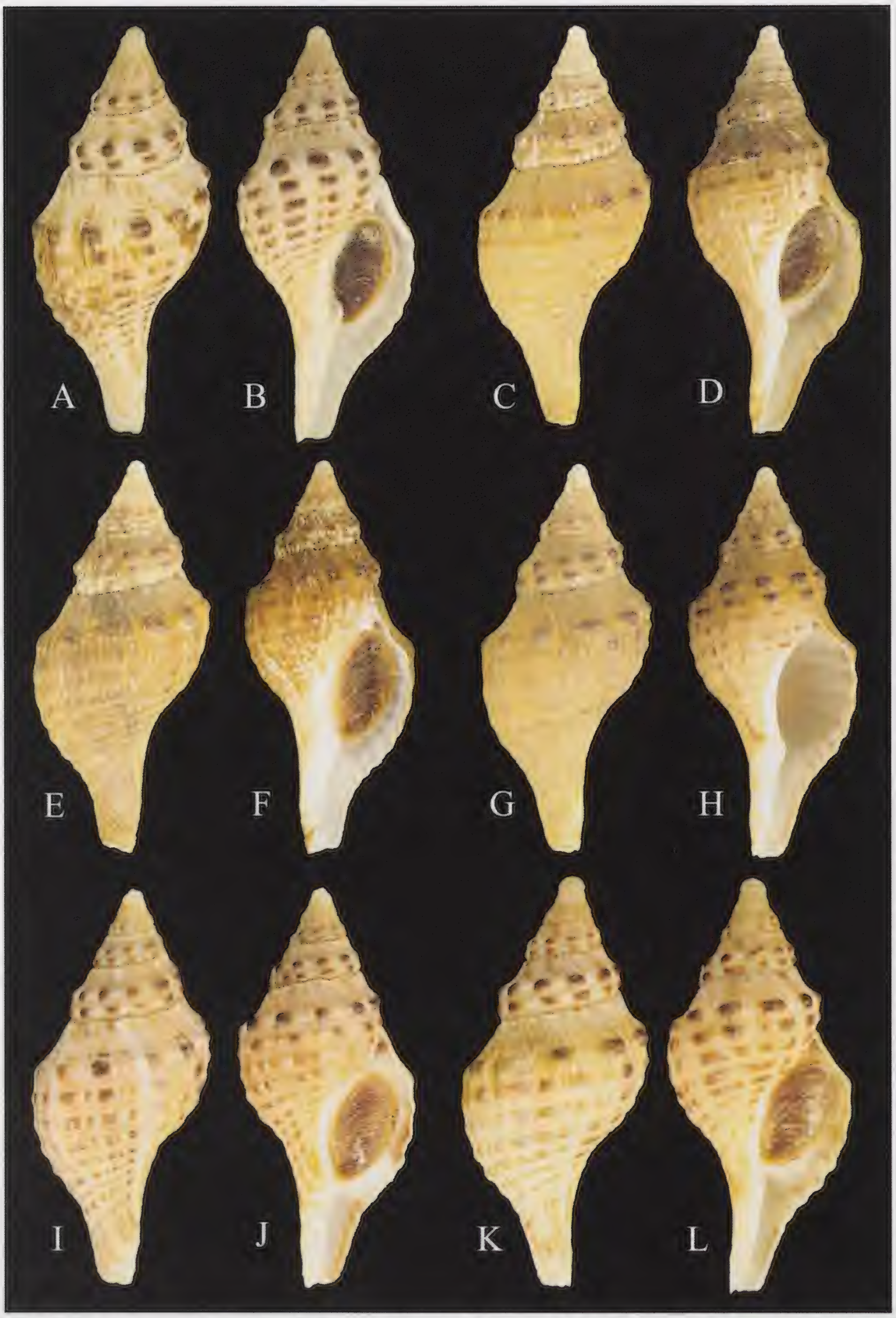

Plate 4. Figures: **A-B** = *Kilburnia emmae* new species (56.29 x 24.16 mm) – Holotype; NMSA Collection, ID No: P1163/T4318, Off Cape St. Francis, in the Southeast Cape area of South Africa, *ca.* 65 metres. **C-D** = *Kilburnia emmae* new species (48.5 x 23.2 mm) – Paratype 1; Off Cape St. Francis, in the Southeast Cape area of South Africa, *ca.* 65 metres.; Seccombe Collection. **E-F** = *Kilburnia emmae* new species (64.8 mm) – Paratype 2; Off Cape St. Francis, in the Southeast Cape area of South Africa, *ca.* 65 metres.; Seccombe Collection. **G-H** = *Kilburnia emmae* new species (52.3 mm) – Paratype 6; Off Cape St. Francis, in the Southeast Cape area of South Africa, *ca.* 65 metres.; Aiken Collection. **I-J** = *Kilburnia emmae* new species (50.2 mm) – Paratype 8; Off Cape St. Francis, in the Southeast Cape area of South Africa, *ca.* 65 metres.; Seccombe Collection. **K-L** = *Kilburnia emmae* new species (47.9 mm) – Paratype 10; Off Cape St. Francis, in the Southeast Cape area of South Africa, *ca.* 65 metres.; Seccombe Collection.

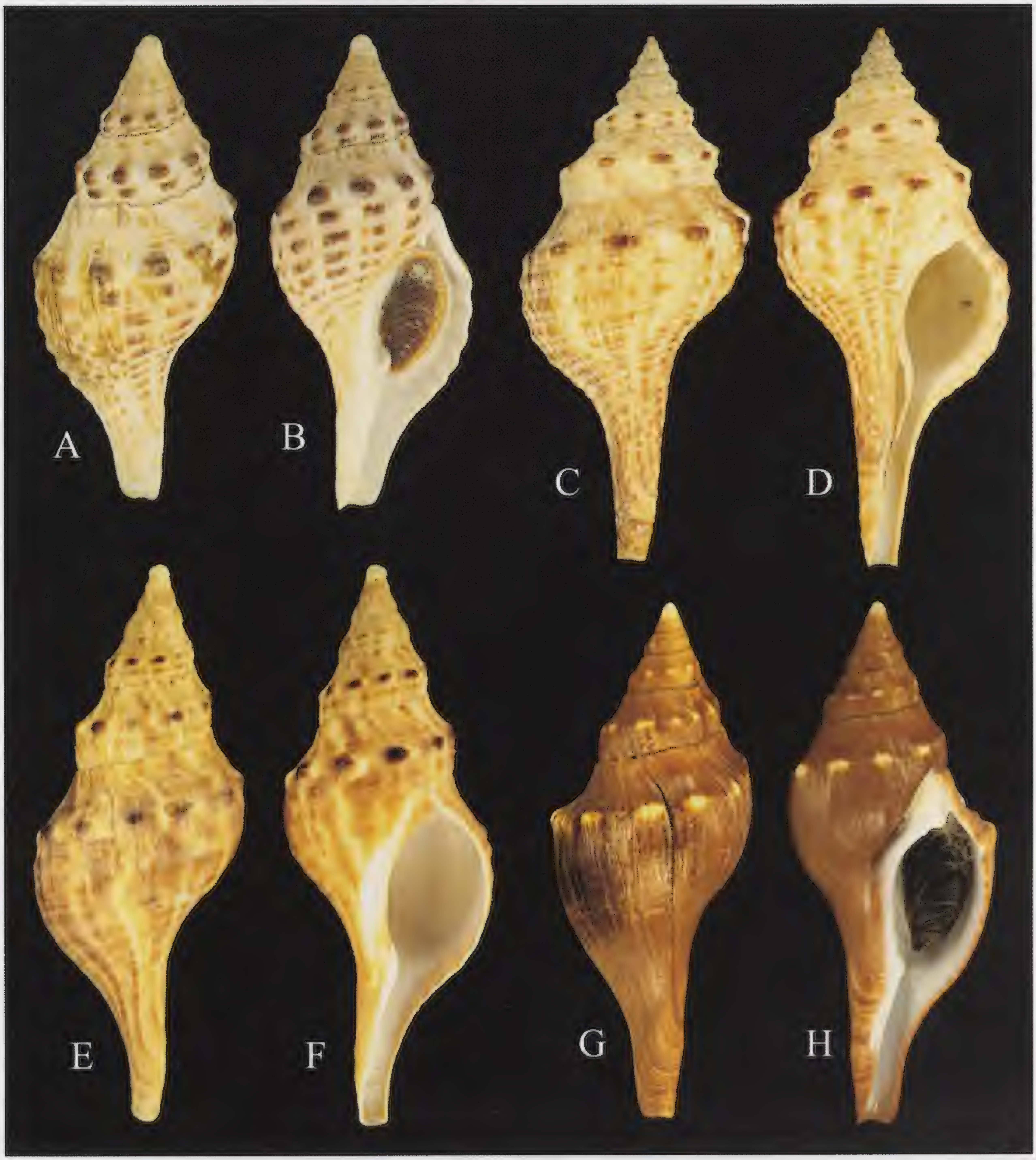

Plate 5. Figures: **A-B** = *Kilburnia emmae* new species (56.29 x 24.16 mm) – Holotype; NMSA Collection, ID No: P1163/T4318, Off Cape St. Francis, in the Southeast Cape area of South Africa, *ca.* 65 metres. **C-D** = *Africofusus adamsii* (Kobelt, 1880) (68.43 mm) – dredged off Cape St Francis in 65 m; Seccombe Collection. **E-F** = *Kilburnia scholvieni* (Strebel, 1911) (87.8 mm), dredged off Cape St Francis in 65 m; Seccombe Collection. **G-H** = *Kilburnia heynemanni* (Dunker, 1876) (80.32 mm), dived off Coffee Bay, Eastern Cape, on sand in 25 m; Seccombe Collection.

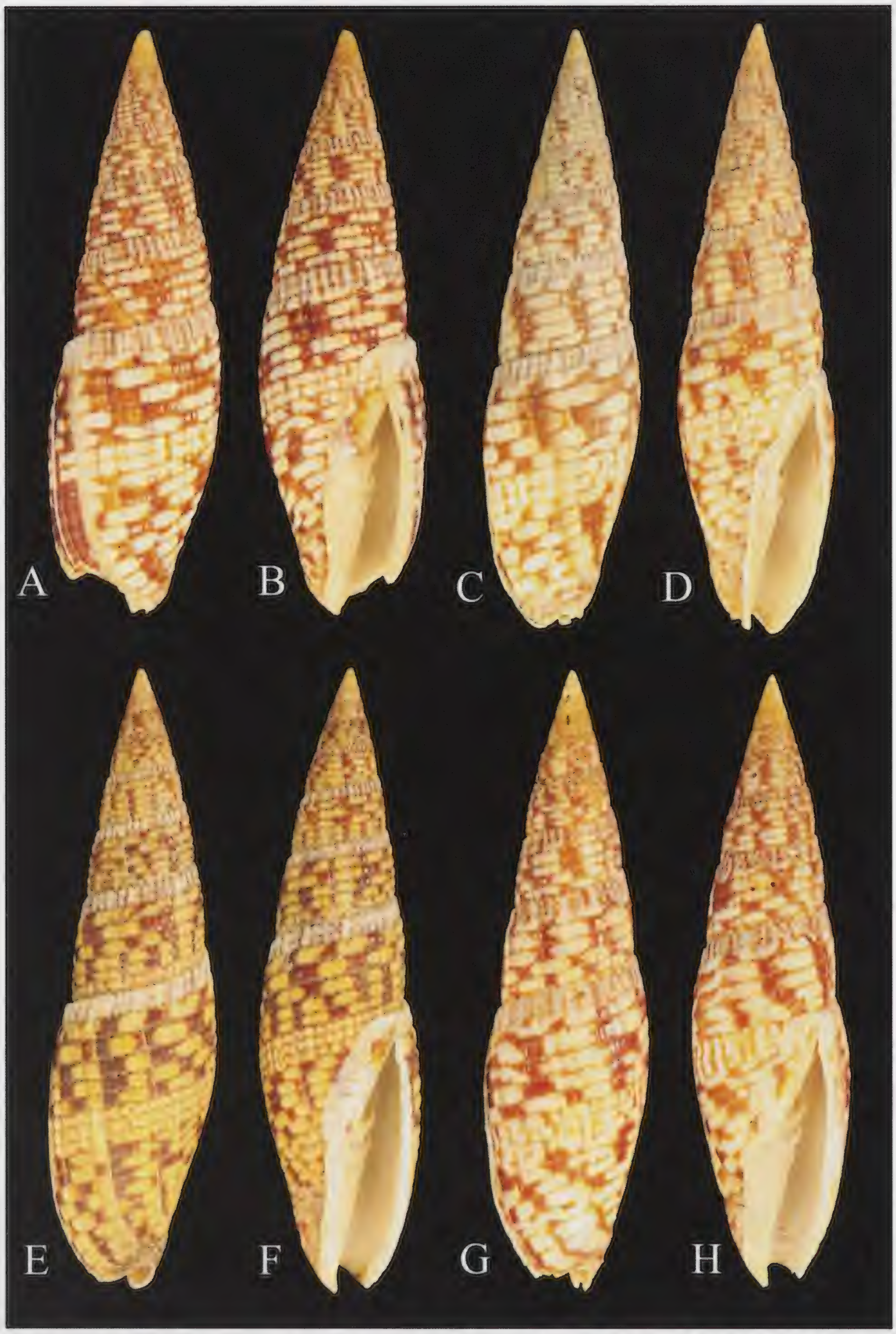

Plate 6. Figures: **A-B** = *Quasimitra rubrolaterculus* new species (63.4 x 18.0 mm) – Holotype; NMSA Collection, ID No: P1164/T4319, off Southern Kwazulu-Natal, South Africa. Dredged at 100 metres. **C-D** = *Quasimitra rubrolaterculus* new species (72.9 x 18.8 mm) – Paratype 1, off Southern Kwazulu-Natal, South Africa. Dredged at 100 metres; Seccombe collection. **E-F** = *Quasimitra rubrolaterculus* new species (69.1 x 18.0 mm) – Paratype 2, off Southern Kwazulu-Natal, South Africa. Dredged at 100 metres; Aiken collection. **G-H** = *Quasimitra rubrolaterculus* new species (64.0 x 17.9 mm) – Paratype 3, off Southern Kwazulu-Natal, South Africa. Dredged at 100 metres; Aiken collection.

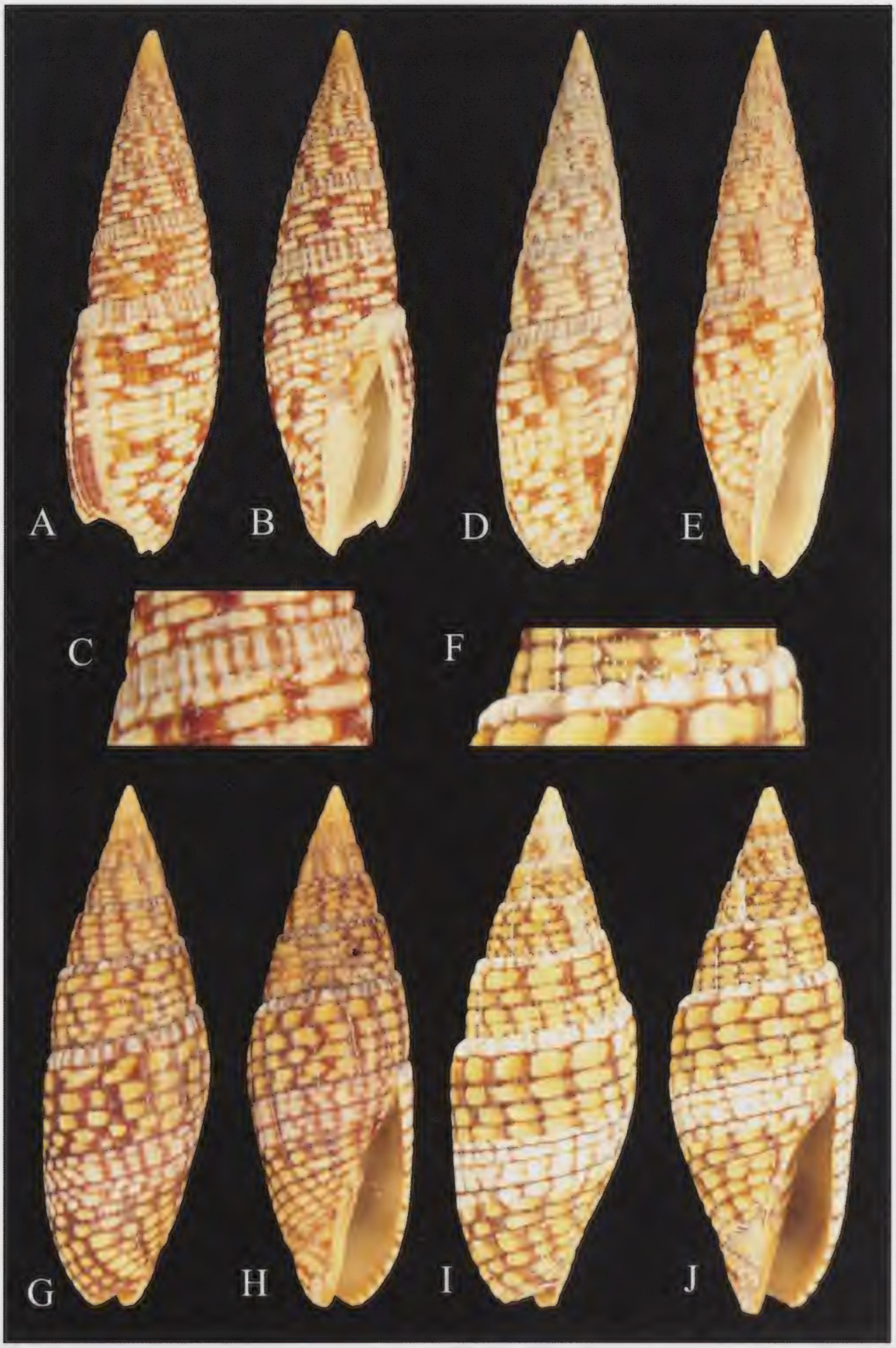

Plate 7. Figures: **A-B** = *Quasimitra rubrolaterculus* new species (63.4 x 18.0 mm) – Holotype; NMSA Collection, ID No: P1164/T4319, off Southern Kwazulu-Natal, South Africa. Dredged at 100 metres. **D-E** = *Quasimitra rubrolaterculus* new species (72.9 x 18.8 mm) – Paratype 1, off Southern Kwazulu-Natal, South Africa. **C** = *Quasimitra rubrolaterculus* new species suture **F** = *Quasimitra sanguinolenta* (Lamarck, 1811) suture. **G-H** = *Quasimitra sanguinolenta* (Lamarck, 1811) (37.0 mm), Live dived off Kwazulu-Natal south coast, 38 m; Aiken Collection. **I-J** = *Quasimitra sanguinolenta* (Lamarck, 1811) (34.6 mm), Live dived off Kwazulu-Natal south coast, 38 m; Aiken Collection.

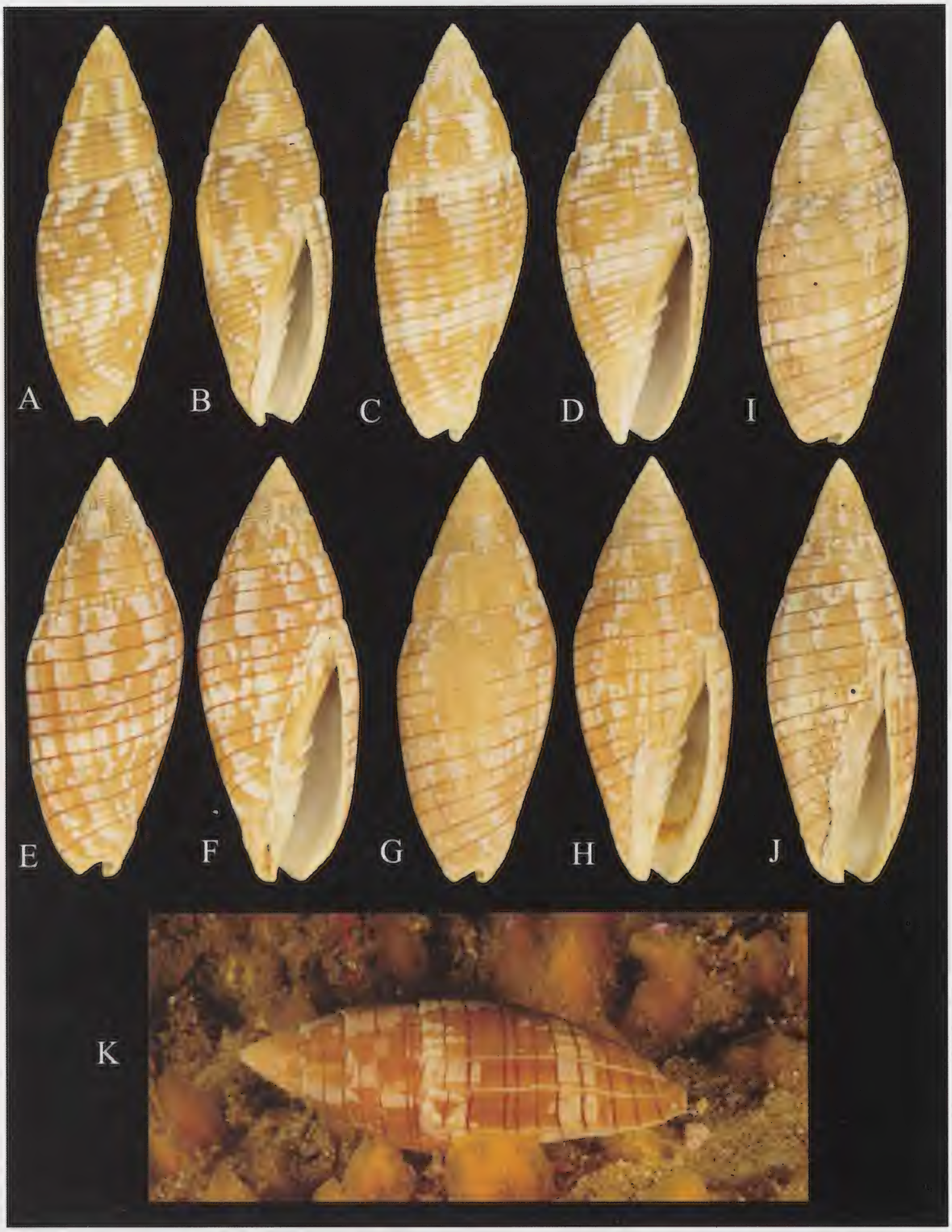

Plate 8. Figures: **A-B**= *Scabricola guttata* (Swainson, 1824) (54.9 x 19.5 mm), Off Kwazulu-Natal south coast, South Africa; Aiken collection. **C-D** = *Scabricola guttata* (Swainson, 1824) (52.7 x 19.1 mm), Off Kwazulu-Natal south coast, South Africa; Aiken collection. **E-F** = *Mitra boswellae* (Cate, 1964) (57.6 mm), Off Richards Bay, Kwazulu-Natal, South Africa; Seccombe collection. **G-H** = *Mitra boswellae* (Cate, 1964) (55.1 mm), Kwazulu-Natal, South Africa; Aiken collection. **I-J** = *Mitra boswellae* (Cate, 1964) (63.68 mm), Kwazulu-Natal, South Africa; Aiken collection. **K** = *Mitra boswellae* (Cate, 1964) Live specimen, Kwazulu-Natal, South Africa; Photographed by Valda Fraser.

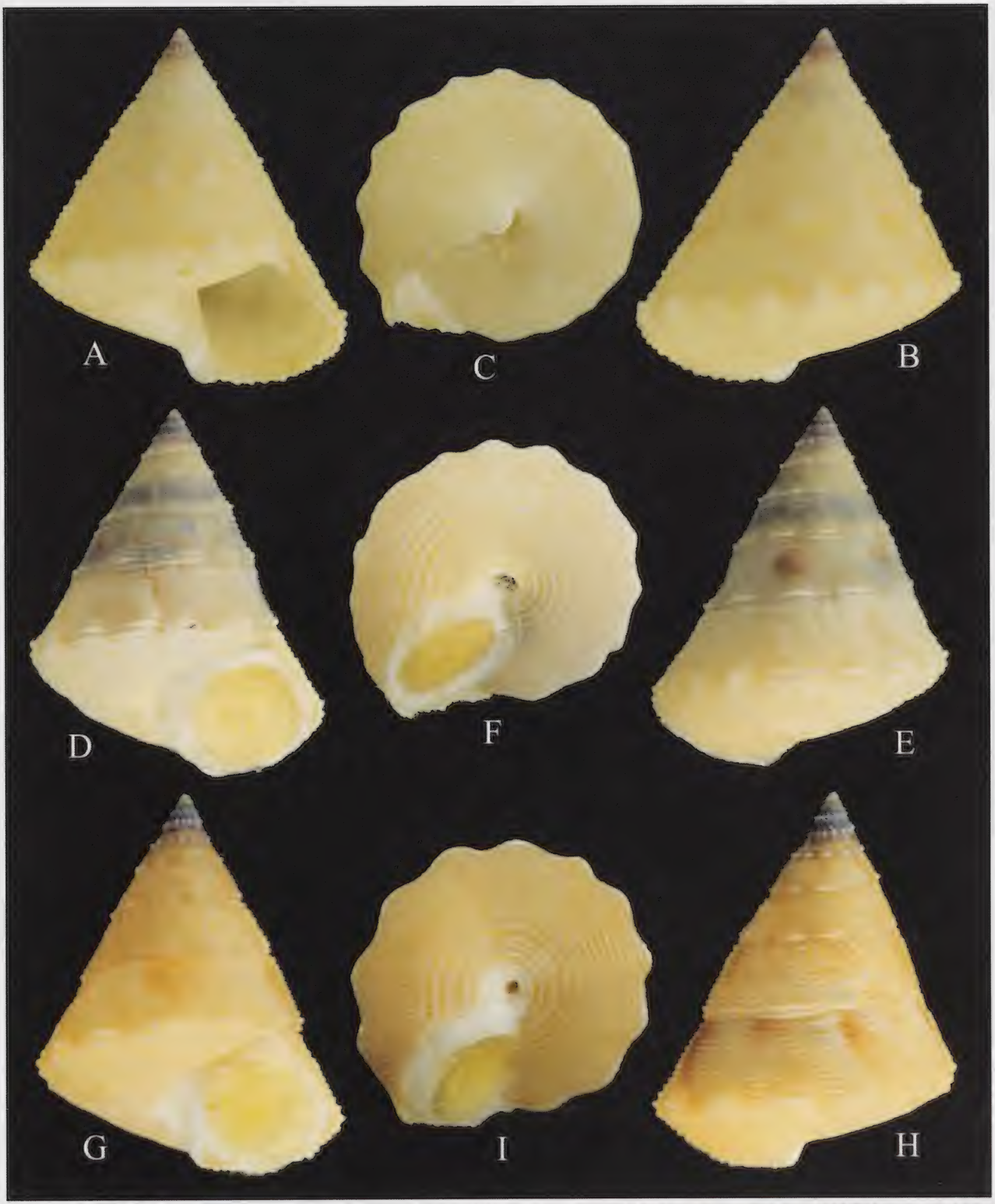

Plate 9. Figures: **A-C** = *Calliostoma margaretae* new species (16.3 x 14.8 mm) – Holotype; NMSA Collection, ID No: P1165/T4320, South Africa, Kwazulu-Natal South Coast, off Hibberdene in 94 to 102 metres. **D-F** = *Calliostoma margaretae* new species (20.2 x 16.5 mm) – Paratype 1; South Africa, Kwazulu-Natal South Coast, off Hibberdene in 94 to 102 metres; Collection A. Seccombe. **G-I** = *Calliostoma margaretae* new species (20.8 x 16.8 mm) – Paratype 2; South Africa, Kwazulu-Natal South Coast, off Hibberdene in 94 to 102 metres; Collection A. Seccombe.

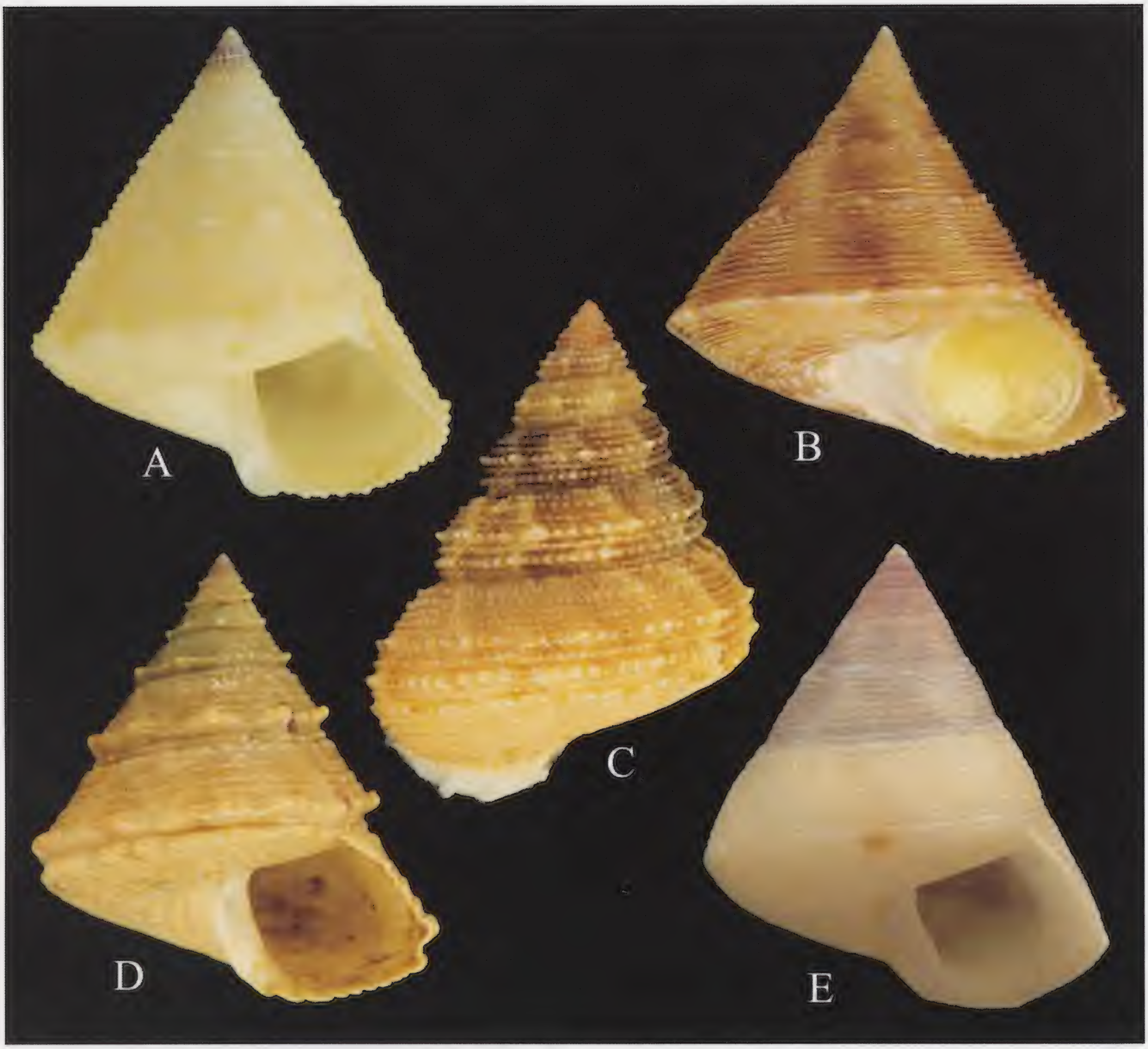

Plate 10. Figures: **A** = *Calliostoma margaretae* new species (16.3 x 14.8 mm) – Holotype; NMSA Collection, ID No: P1165/T4320, South Africa, Kwazulu-Natal South Coast, off Hibberdene in 94 to 102 metres. **B** = *Calliostoma iridescens* G.B. Sowerby III, 1903 (18.34 mm); Seccombe Collection. **C** = *Tristichotrochus crossleyae* (E. A. Smith, 1910) (14.65 mm); Seccombe Collection. **D** = *Calliostoma layardi* G.B. Sowerby III, 1897 (19.5 mm); Aiken Collection. **E** = *Calliostoma aikeni* Lussi, 2014 (13.03 mm); Seccombe Collection.

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New Species of Mollusks (Gastropoda and Bivalvia) from the Tropical Western Atlantic, West Africa, and Red Sea

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ABSTRACT Eight new species of mollusks are described from the Gulf of Mexico, Virgin Islands, and Brazil in the Tropical Western Atlantic, and also Gambia, West Africa and the Gulf of Aqaba, northern Red Sea. These new taxa include: the muricid *Jaton rikae* n. sp. from Gambia; six cone shells including *Darioconus bratcherae* n. sp. from the Gulf of Aqaba, *Jaspidiconus tammymyersae* n. sp. from the Virgin Islands, and the Brazilian species *Jaspidiconus ramosorum* n. sp., *Jaspidiconus serafimi* n. sp., *Jaspidiconus toincabrali* n. sp., and *Poremskiconus potiguar* n. sp.; and the Floridian Ten Thousand Islands endemic venerid bivalve *Mercenaria browni* n. sp..

KEY WORDS Muricidae, Conidae, Veneridae, *Jaton*, *Darioconus*, *Jaspidiconus*, *Poremskiconus*, *Mercenaria*, Gulf of Mexico, Ten Thousand Islands, Gambia, Gulf of Aqaba, Virgin Islands, Brazil

INTRODUCTION

Through the generosity of several shell dealers, inspired amateur malacologists, and local naturalists, a large number of new species of gastropods and bivalves recently have been brought to our attention. These unnamed mollusks have been sent to us in support of an ongoing research project that we are currently conducting on worldwide marine biogeography and molluscan biodiversity. We are especially grateful to Damaso Monteiro of Portugal and Brazil, Rika Goethaels and Fernand De Donder of Belgium, and Marcus and Jose Coltro of Brazil and Italy for recognizing these species as new and generously donating specimens of each for description. We also wish to recognize A. Kenneth ("Kenny") Brown of Chokoloskee Island, Florida who, along with his family members, has enthusiastically supported our ongoing research on the biodiversity of the Ten Thousand Islands, Florida. Out of the large amount of study material that we have received from these individuals, eight taxa were important enough to our research that we have decided to formally describe them here. All of these new gastropods will be illustrated and discussed in our up-coming book on marine biogeography, Illustrated Guide to Marine Molluscan Biogeography (Tropical and Warm Temperate Seas), and the new venerid bivalve will be illustrated and discussed in another up-coming book, Shells and Marine Life of the Ten Thousand Islands, Southwestern Florida.

The holotypes of the new species are deposited in three different museums: in the Collection Mollusques, Museum National d'Histoire Naturelle, Paris, France (with an MNHN catalog number); in the molluscan collections, Zoological Museum of the University of Sao Paulo, Sao Paulo, Brazil (with MZSP catalog numbers); the Department of Malacology, Los Angeles County Museum of Natural History, Los Angeles, California (with LACM catalog numbers).

SYSTEMATICS

Class Gastropoda
Subclass Sorbeoconcha
Order Prosobranchia
Infraorder Neogastropoda
Superfamily Muricoidea
Family Muricidae
Subfamily Ocenebrinae
Genus *Jaton* Pusch, 1837

Jaton rikae Petuch and Berschauer, new subspecies
(Figure 1 A, B)

Description. Shell small for genus, elongated and fusiform, with low, stepped spire and protracted siphonal canal; body whorl roughly triangular in shape, grading directly into wing-like varix on margin of siphonal canal; shoulder sharply angled, with flattened subsutural area on body whorl and flattened, tabulate spire whorls; 3 thick and flattened varices per whorl, with edge of varix having slight undulations that correspond to 5 low, rounded longitudinal cords; cord around shoulder being largest in size and having best development, forming prominent shoulder keel; body whorl and spire whorl surfaces smooth and waxy, with fine crenulations and frills present only on ventral side of each varix; siphonal canal portion of varix best developed, producing broad shelf-like extension; single large rounded knob present between each pair of varices; shell color pale cream-white with 2 or 3 thin brown bands around middle of body whorl, crossing dorsal and ventral sides of each varix and intervarical knobs; scattered small brown dots and patches also present along shoulder cord, on posterior end of intervarical knobs, along the varical wing of the siphonal canal, and on the anterior tip; aperture oval in shape, proportionally very large, edged with a thin, raised peristomal ridge; outer edge of lip with dentate peristome, being ornamented with 5 proportionally-large, low, rounded teeth and numerous fine fimbriations.

Material Examined. HOLOTYPE - length 18.7 mm, width 10.2 mm, off Gunjur, Gambia, MNHN-IM-2000-35012; OTHER MATERIAL EXAMINED - 2 specimens, lengths 14.1 mm and 18.0 mm, from the same locality as the holotype, in the research collection of the senior author; 1 specimen, length 15.1 mm, from the same locality as the holotype, in the research collection of the junior author; 8 specimens, lengths 13.1 mm to 19.9 mm, from the same locality as the holotype, in the De Donder-Goethaels collection, Peutie, Belgium; 2 specimens, lengths 17.6 mm and 19.5 mm, from the same locality as the holotype, in the research collection of Roland Houart, Belgium.

Type Locality. The holotype was collected from fishermen’s nets set in 3-5 m depth, off Gunjur, Gambia.

Distribution. Known only from the coast of Gambia and the area near the mouth of the Gambia River.

Etymology. The new taxon honors Rika Goethaels of Peutie, Belgium who, along with Fernand De Donder, discovered the new *Jaton* during their explorations in Gambia and kindly donated the type lot of specimens.

Discussion. With the discovery of this new Gambian ocenebrine muricid, five species of *Jaton* are now known to inhabit the West African coast. These include (on a north-south gradient): *Jaton hemitripterus* (Lamarck, 1816) from southern Morocco and Western Sahara; *Jaton flavidus* (Jousseaume, 1874) from Senegal; *Jaton rikae* Petuch and Berschauer, new species, from Gambia; *Jaton decussatus* (Gmelin, 1791) from Senegal to Gabon; and *Jaton sinespina* Vermeij and Houart, 1996 from Angola. Of these, *Jaton rikae* is most similar to the Moroccan and Western Saharan *Jaton hemitripterus* (Figure 1 C, D), but differs in being a much smaller shell that averages only one-half the length of the Saharan coastal species, in having a proportionally lower spire, in having a less-sculptured shell that has a smooth, waxy shell surface, in lacking the strong spiral cords seen on *J. hemitripterus*, and in being a more colorful shell, having three thin brown spiral bands on the body whorl and small brown patches scattered over the intervarical knobs and anterior tip. Biogeographically and ecologically, *J. rikae* and *J. hemitripterus* are also very different, with *J. rikae* being found only on muddy sea floors and mud-covered rocky platforms along the coast of Gambia, and with *J. hemitripterus* being found under rocks in the intertidal zone only along southern Morocco, Western Sahara, and extreme northernmost Mauritania. No individuals of *J. hemitripterus* are known from south of Western Sahara and northern Mauritania and the species has never been collected along the intervening coasts of southern Mauritania or Senegal, especially in the Cap-Vert Peninsula area. This geographical separation, and the accompanying gene flow barrier, support the species-level status of the new Gambian muricid.

Superfamily Conoidea
Family Conidae
Subfamily Coninae
Genus *Darioconus* Iredale, 1930

Darioconus bratcherae Petuch and Berschauer, new species
(Figure 1 E, F)

Description. Shell of average size for genus, shiny and polished, cylindrical and fusiform, narrow across shoulder, with slightly convex sides; shoulder rounded, only slightly angled, with sloping and faintly canaliculate subsutural area; spire elevated, distinctly pyramidal, with domed early whorls; spire whorls slightly canaliculate; body whorl and spire whorls pure white, overlaid by network of large and small interconnected reddish-brown triangles; some large triangles fuse into broad open white patches which are often separated by large reddish-brown amorphous patches containing numerous small darker brown spiral lines of tiny dots and dashes and minute white triangles; areas between small triangles often filled with clusters of minute triangles in fractal pattern; spire whorls also covered with diffuse network of reddish-brown triangles and scattered darker brown patches; early whorls and protoconch bright pink; protoconch aculeiform, projecting; aperture proportionally wide, expanding toward anterior end.

Material Examined. HOLOTYPE - length 33.6 mm, width 15.9 mm, Eilat, Gulf of Aqaba, Israel, LACM 3730; OTHER MATERIAL EXAMINED - 2 specimens, lengths 47.0 mm and 51.0 mm, from the same locality as the holotype, in the research collection of the senior author; length 41.7 mm, from the same locality, in the research collection of the junior author.

Type Locality. Found on sand and coral rubble, 2 m depth, off Eilat, Israel, Gulf of Aqaba.

Distribution. The new species is confined to the northern Red Sea, including the entire Gulf of Aqaba and the adjacent Egyptian coast from Sharm el-Sheikh and Hughada to Safaga. *Darioconus bratcherae* may also be present throughout the entire northern half of the Red Sea, but little data on the mollusks of that area exists and the range of the new species is still conjectural.

Etymology: The new taxon honors the memory of Twila Bratcher, late of Hollywood, California, a renowned diver and an inspired malacologist,

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who collected the holotype on one of her expeditions to the Gulf of Aqaba. Twila Bratcher was also one of the pioneer women SCUBA divers and was recently inducted, posthumously, into the Women Divers Hall of Fame.

Discussion. *Darioconus bratcherae* has often been misidentified as the closely-related *Darioconus quasimagnificus* (da Motta, 1982) (Figure 1 G, H), which was originally described from the Gulf of Oman and is now known to range into the Gulf of Aden and the southern Red Sea. The new Gulf of Aqaba species is morphologically close to the flat-spired *D. quasimagnificus* but differs in being a much more slender and elongated shell that is narrower across the shoulder, in consistently having a higher spire with sloping whorls and a rounded shoulder, in having a much lighter color pattern with a reddish-brown triangular network instead of dark purple-brown network and large dark brown patches and bands, and in having a more diffuse triangle pattern with proportionally larger triangles. In this last shell character, the new species more closely resembles the Persian Gulf *D. laueri* Monnier and Limpalaer, 2013 than it does the Omanian and southern Red Sea *D. quasimagnificus*.

Poremskiconus potiguar Petuch and Berschauer, new species
(Figure 1 I, J)

Description. Shell of average size for genus, stocky with slightly rounded sides; shoulder sharply-angled, edged with pronounced carina; spire elevated, pyramidal, slightly scalariform; body whorl shiny and polished, with 15-20 very low, faint spiral threads which become more numerous and stronger toward anterior end; body whorl color variable, ranging from red and orange to yellow and khaki green; colored sections of body whorl overlaid with variable number of very fine darker-colored spiral threads and rows of tiny dots; mid-body marked with wide band of large white flammules, with some fusing into solid white band; white mid-body band often edged with small pale reddish-brown flammules; spire whorls and shoulder carina white, with 10-12 large, prominent, evenly-spaced reddish-brown flammules per whorl; spire flammules extend onto white shoulder carina, producing distinctive checkered pattern; aperture proportionally narrow, slightly arcuate; interior of aperture varying with color of individual, being lighter-colored version of exterior body whorl color.

Material Examined. HOLOTYPE - length 20.9 mm, width 10.6 mm, off Tibau do Sul, Brazil, MZSP 144897; OTHER MATERIAL EXAMINED - 2 specimens, lengths 21.1 mm, and 22.0 mm, from the same locality as the holotype, in the research collection of the senior author, length 19.4 mm, from the same locality, in the research collection of the junior author.

Type Locality. The holotype was collected in a lobster trap set at 10 m depth, on the coralline algal reef systems off Tibau do Sul, Rio Grande do Norte State, Brazil.

Distribution. Known only from the area off Tibau do Sul, Rio Grande do Norte State, Brazil.

Etymology. Named for a “Potiguar”, a Tupi Indian name meaning “he who eats shrimp”, now considered a nickname for anyone from Rio Grande do Norte State, Brazil. The name is proposed as a noun in apposition and honors the people of Rio Grande do Norte State.

Discussion. *Poremskiconus potiguar* is the newest-known member of a close-knit species complex that inhabits coralline algal reef systems off the coasts of Ceara and Rio Grande do Norte States, northern Brazil. Members of this species group have direct development in their larval stages and cannot disperse beyond their home reef systems. This genetic isolation has led to the evolution of a northern Brazilian species radiation containing at least six distinct taxa, which include: *Poremskiconus mauricioi* (J. Coltro, 2004) from Rio do Fogo, Rio Grande do Norte State (type locality); *P. fonsecai* Petuch and Berschauer, 2016 also from Rio do Fogo, Rio Grande do Norte State; *P. smoesi* Petuch and Berschauer, 2016 from Camocim, Ceara State; *P. tourosensis* Petuch and Berschauer, 2018 from Touros, Rio Grande do Norte State; *P. mariaodeteae* Petuch and Myers, 2014 from Camocim, Ceara State; and *P. potiguar* Petuch and Berschauer, n. sp. from Tibau do Sul, Rio Grande do Norte State (see Petuch and Berschauer, 2016; 2018 and Petuch and Myers, 2014).

Of these taxa, *Poremskiconus potiguar* most closely resembles *P. mauricioi* from northeastern Brazil (Figure 1 K, L), especially in having white spire whorls with darker crescent-shaped flammules and a white shoulder carina marked with tan or brown, evenly-spaced checkers. The new species differs from *P. mauricioi* in being a consistently smaller and more slender shell with a higher, more protracted spire, and in lacking the large, prominent band of dark brown flammules around the mid-body. The spire of *P. potiguar* is distinctly pyramidal and scalariform while the spire of *P. mauricoi* is noticeably flatter. In this regard, the new species shows a close resemblance to *P. fonsecai*, also from Rio Grande do Norte State, but differs in being a larger and much more colorful shell, with intense orange and yellow colors and with dark brown flammules on the spire whorls and shoulder carina. *Poremskiconus fonsecai* also differs from *P. potiguar* in having proportionally stronger spiral threads around the body whorl, giving the shell a rougher look.

Subfamily Conilithinae
Genus *Jaspidiconus* Petuch, 2004

Jaspidiconus ramosorum Petuch and Berschauer, new species

(Figure 2 A, B)

Description. Shell of average size for genus, slender, elongated and cylindrical, with straight sides; shoulder sharply-angled, bordered by pronounced sharp carina; spire elevated, pyramidal in shape, subscalariform; body whorl smooth and shiny, sculpted with 14-16 thin, faintly-incised spiral sulci which become stronger and closer together at anterior end; young specimens have strong spiral sulci which become fainter and almost obsolete on mature specimens; body whorl deep blue or blue-purple overlaid with numerous dark brown and pale bluish-white longitudinal flammules arranged in irregular zebra-striped pattern; spire whorls pale blue, with widely-spaced dark brown flammules arranged in radiating pattern; spire flammules extend onto shoulder carina, producing distinct checkered pattern; first 4-5 whorls and protoconch pale orange in color; aperture narrow, straight, dark brown within interior; protoconch proportionally large, bulbous, mammilate, composed of 2 dome-like whorls.

Material Examined. HOLOTYPE - length 19.8 mm, width 9.5 mm, off Nova Vicosa, Bahia State, Brazil, MZSP 144894; OTHER MATERIAL EXAMINED - length 22.0 mm, from the same locality as the holotype, in the research collection of the senior author; length 13.0 mm, from the same locality as the holotype, in the research collection of the junior author.

Type Locality. The holotype was collected on sand and coral rubble in 25 m depth off Nova Vicosa, Bahia State, Brazil, on the Abrolhos Platform.

Distribution. Known only from the Abrolhos Platform area off Nova Vicosa, Bahia State, Brazil.

Etymology. The new taxon honors Fabiano Ramos and the Ramos Family of Alcobaca, Bahia State, Brazil, who collected the type lot of the new species.

Discussion. Of the known southern and central Brazilian Province *Jaspidiconus* species, only *J. simonei* Petuch and Myers, 2014 comes closest to the new species in general shell shape and spire development. This species is the southernmost member of the genus *Jaspidiconus* and is found on intertidal sand bars from Guarapari, Espirito Santo State south to Cabo Frio, Rio de Janeiro State. The tropical Abrolhos Platform - dwelling *J. ramosorum* differs from its colder water congener, *J. simonei*, in having a more slender and cylindrical shell, in having more distinct incised spiral sulci, in having a darker-colored shell with a distinct brown and blue zebra pattern, in having distinct dark checkers on the shoulder carina and radiating stripes on the spire whorls, in having a bright orange protoconch and early whorls.

Jaspidiconus serafimi Petuch and Berschauer, new species
(Figure 2 C, D)

Description. Shell of average size for genus, stocky, barrel-shaped, inflated, with rounded, convex sides; shoulder sharply-angled, bordered by low, rounded carina; spire elevated, pyramidal in shape, slightly scalariform; body whorl smooth and shiny, sculpted with 12-14 evenly-spaced incised spiral sulci, which become larger and more deeply-impressed on anterior one-half of body whorl; deeply-incised sulci of anterior end produce 6-8 large, prominent spiral cords; body whorl base color pale pinkish-tan, overlaid with variable amounts of darker pinkish-tan amorphous flammules, often arranged in longitudinal zig-zag pattern; spire whorls pale pinkish-white marked with widely-scattered dark reddish-brown irregular flammules; early whorls and protoconch pale yellow-white; edge of carina marked with row of 12-18 evenly-spaced large reddish-brown dots, some of which connect to spire flammules; aperture proportionally wide and flaring, becoming wider toward anterior end; interior of aperture pale pinkish-tan.

Material Examined. HOLOTYPE - Length 17.7 mm, width 9.1 mm, off Tibau do Sul, Rio Grande do Norte State, Brazil, MZSP 144896; OTHER MATERIAL EXAMINED - 3 specimens, 16.2 mm, 18.1 mm, and 19.0 mm, from the same locality as the holotype, in the research collection of the senior author; length 17.2 mm, from the same locality as the holotype, in the research collection of the junior author.

Type Locality. The holotype was collected in a lobster trap set at 10 m depth, on the coralline algal reef systems off Tibau do Sul, Rio Grande do Norte State, Brazil.

Distribution. Known only from the area off Tibau do Sul, Rio Grande do Norte State, Brazil.

Etymology. The new taxon honors Fernando Serafim of Lisboa, Portugal, well-known Portuguese tenor and opera singer and inspired amateur malacologist.

Discussion. Of the known northern and central Brazilian Province *Jaspidiconus* species, *J. serafimi* is most similar to the central Bahia State endemic *J. josei* Petuch and Berschauer, 2016. Although having the same rotund and inflated shell shape, the new Rio Grande do Norte species differs from the Bahian *J. josei* in having a smaller and more slender shell, in having a higher and more protracted spire, in having a much paler shell color and color pattern, in having the deeply-incised sulci around the body whorl, and in having the prominent thick spiral cords around the anterior end and siphonal region.

Jaspidiconus tammymyersae Petuch and Berschauer, new species
(Figure 2 E, F)

Description. Shell very small for genus, fusiform, with slightly rounded sides; shoulder sharply angled, subcarinate; spire high and protracted with slightly stepped whorls, distinctly pyramidal; body whorl smooth and shiny, with anterior one half ornamented with 10-12 evenly-spaced incised spiral sulci which become stronger and close together toward anterior end; spire whorls smooth and shiny, ornamented with very numerous closely-packed crescent-shaped growth increments; shell color uniform pale yellow cream overlaid with 2 bands of large, very pale orange amorphous patches, one below shoulder and one around anterior one-third of body whorl; spire with scattered large pale orange amorphous patches; aperture proportionally wide, becoming wider toward anterior end; interior of aperture bright yellow; protoconch proportionally very large, bulbous, mammilate, composed of 2 whorls, pale orange in color.

Material Examined. HOLOTYPE - length 13.3 mm, width 6.7 mm, Little St. James Island, US Virgin Islands, LACM 3659; OTHER MATERIAL EXAMINED - 2 specimens, 12.2 mm and 14.1 mm, from the same locality as the holotype, in the research collection of the senior author; length 13.4 mm, from the same locality as the holotype, in the research collection of the junior author.

Type Locality. The holotype of *Jaspidiconus tammymyersae* was collected on a clean coral sand sea floor in 8 m depth off Little St. James Island, U.S. Virgin Islands. The type lot was collected by Gary Mackintosh.

Distribution. Known only from the area around Little St. James Island, United States Virgin Islands, where the new species lives on clean coral sand bottoms near coral reefs.

Etymology. The new taxon honors Tammy Bailey Myers of Ormond Beach, Florida, an inspired amateur malacologist and naturalist and a lover of the Conidae.

Discussion. Of the known northern Caribbean *Jaspidiconus* species (Antillean Subprovince of the Caribbean Province; see Petuch, 2013), *J. tammymyersae* most closely resembles *J. culebranus* Petuch, Berschauer, and Poremski, 2016 from Culebra Island east of Puerto Rico. The new species differs from the Culebra Island endemic in being a smaller and more slender shell that is narrower across the shoulder, in having a narrower spire profile, in being a more colorful shell with pale orange amorphous blotches and a bright yellow aperture interior, and in having a much larger and more bulbous protoconch.

Jaspidiconus toincabrali Petuch and Berschauer, new species
(Figure 2 G, H)

Description. Shell of average size for genus, stocky and inflated, rotund, wide across shoulder; spire elevated and protracted, subpyramidal, distinctly stepped and scalariform; shoulder sharply angled, bordered by large undulating carina; body whorl shiny and polished, heavily ornamented with 12-14 spiral rows of proportionally-large rounded, bead-like pustules; deep spiral sulcus present between rows of pustules; shoulder carina edged with row of large pustules, producing distinct coronated appearance; body whorl and spire whorls pure white, infused with large, widely-scattered patches of very pale orange or yellow; some specimens with very small, pale orange spots present between shoulder coronations and on edges of spire whorls (as on holotype); aperture proportionally wide, flaring, becoming wider toward anterior end; interior of aperture white; protoconch, proportionally large, mammillate, composed of 2 ½ whorls, white in color.

Material Examined. HOLOTYPE - length 14.0 mm, width 8.0 mm, from off Tibau do Sul, Rio Grande do Norte State, Brazil; OTHER MATERIAL EXAMINED - 4 specimens, lengths 13-18 mm, from the same locality as the holotype, in the research collection of the senior author; 3 specimens, lengths 14-17 mm, from the same locality as the holotype, in the research collection of the junior author.

Type Locality. The holotype was collected in a lobster trap set at 10 m depth, on the coralline algal reef systems off Tibau do Sul, Rio Grande do Norte State, Brazil.

Distribution. Known only from the area off Tibau do Sul, Rio Grande do Norte State, Brazil.

Etymology. The new taxon honors Antonio ("Toin") Jose Cabral of Rio Grande do Norte State, Brazil, who collected the type lot of specimens from lobster traps off Tibau Norte.

Discussion. At first glance, this heavily pustulated rotund cone shell somewhat resembles a small white raspberry. Of all the Brazilian pustulated *Jaspidiconus* species, such as *J. crabosi* Petuch and Berschauer, 2018, *J. ogum* Petuch and Myers, 2014, *J. henckesi* (J. Coltro, 2004), and *J. damasomonteiroi* Petuch and Myers, 2014, the new Rio Grande do Norte *J. toincabrali* has, proportionally, the largest pustules and the strongest pustulated shell ornamentation (see Petuch and Berschauer, 2018 for an overview of some of the northern Brazilian *Jaspidiconus* species). In both general shell shape and arrangement of the pustules, *J. toincabrali* is most similar to *J. damasomonteiroi* from Camocim, Ceara State, but differs in being a smaller, stockier, and less elongated species, in having a proportionally lower spire, and in having a white shell color as opposed to the intense pinks, oranges, and brown flammules seen on *J. damasomonteiroi*.

Class Bivalvia
Subclass Heterodonta
Order Veneroida
Superfamily Veneroidea
Family Veneridae
Subfamily Chioninae
Genus *Mercenaria* Schumacher, 1817

Mercenaria browni Petuch and Berschauer, new species

(Figure 3 A, B)

Description. Shell small for genus, thin, ovately rounded in outline, dorsoventrally compressed; lunule proportionally large, compressed and elongated, subcardiform, bounded by deeply-incised lines; inner margin of commissure crenulate; umbones recurved, only slightly prosogyrate; shell exterior sculpted with numerous strong, rough, closely-packed raised concentric growth lines; 1/3 to 1/2 of the post-umbonal early shell growth ornamented with proportionally-large, strong, widely-separated concentric lamellae; shell color pale cream-white, with large purple-brown patches and purple bands being present on escutcheon area and umbones; interior of shell white with thin purple line present around anterior and posterior shell margins; pallial sinus deeply reflexed and coming to sharp point; both valves with 3 cardinal teeth, with broad central tooth being bifurcated by shallow groove.

Material Examined. Holotype - length 71.3 mm, width 64.0 mm, Round Key, Ten Thousand Islands, Collier County, Florida, LACM 3731; OTHER MATERIAL EXAMINED - 3 specimens, lengths 48 mm, 83 mm, and 93 mm, from the same locality as the holotype, in the research collection of the senior author; 2 specimens, lengths 76 mm and 85 mm, from the same locality as the holotype, in the collection of A. Kenneth ("Kenny") Brown, Chokoloskee Island.

Type Locality. On muddy-sand flats at low tide, northern side of Round Key, Ten Thousand Islands, Collier County, Florida.

Distribution. Known only from the tidal creeks and lagoons of the Ten Thousand Islands of Collier and Monroe Counties, Florida, from Cape Romano south to the mouth of the Shark River.

Etymology. The new taxon honors A. Kenneth ("Kenny") Brown, Jr. of Chokoloskee Island, Florida, an inspired amateur naturalist who has provided us with years of invaluable aid and assistance while conducting our research in the Ten Thousand Islands.

Discussion. In 1902, William Healey Dall discovered and named a small oval-shaped venerid bivalve that he had found living within the brackish lagoons and estuaries of the Texas coast. This endemic Texas bivalve, *Mercenaria texana* (Dall, 1902) (Figure 3 F), was found to occur along with the larger, ubiquitous Gulf and U.S. East Coast *Mercenaria campechiensis* (Gmelin, 1791) (Figure 3C, D). Although sympatric within the Texas lagoon systems, the widely-distributed *M. campechiensis* was found to prefer more saline water with fewer salinity fluctuations. On the other hand, *M. texana* was found to prefer more estuarine conditions, within areas of wildly-fluctuating salinities and was actually only sympatric with its larger congener in a narrow area of stable water conditions. Over one hundred years after Dall's discovery, the senior author discovered another estuarine sibling of *M. campechiensis*, this time in the coastal lagoon systems of Martin and Palm Beach Counties, Florida (Petuch, 2013: 16, 42, 225-226). Named *Mercenaria hartae* (Figure 3 E), this Palm Beach estuarine endemic resembles *M. texana* (Figure 3 F) in shape and size but differs in having smooth areas on the shell exterior and having a bright canary-yellow shell color.

The discovery of a third estuarine sibling species of *Mercenaria campechiensis* is truly remarkable. This new dwarf venerid, *Mercenaria browni*, closely resembles both *M. texana* and *M. hartae* in shape and size, but is less colorful in being only a cream-white as opposed to the pale brown and tan pattern on *M. texana*, or the bright canary-yellow color of *M. hartae*. The new Ten Thousand Islands species lives together with, and is morphologically closest to, *M. campechiensis*, but differs in consistently having a smaller, more rounded and oval-shaped shell, in having a thinner and much more flattened shell, and in having the distinctive large, widely-spaced concentric lamellae on the early post-umbonal areas. The shell of the widespread Carolinian Province *M. campechiensis* differs from the new species in being much larger, thicker, and heavier and also in being much more triangular in shape, with a higher and more projecting umbonal area. The lunules of the two species also differ greatly, reflecting the flatter shell of *M. browni* and the more inflated shell of *M. campechiensis*. On the new species, the lunule is elongately heart-shaped with the umbones only slightly projecting over the posterior end of the lunule. On *M. campechiensis*, the lunule is essentially round, or only slightly heart-shaped, and the umbones project out over the posterior end of the lunule and are more noticeably prosogyrate. The pallial sinus of *M. browni* is well-developed and deeply reflexed (Figure 3 B), while the pallial sinus of *M. campechiensis* is much shallower and not as reflexed (Figure 3 D). These differences indicate that *M. browni* burrows more deeply than does *M. campechiensis*, apparently to avoid the seasonal extreme fluctuations in salinity within the tidal channels and brackish lagoons of the Ten Thousand Islands.

The Eastern American venerid genus *Mercenaria* is now known to be more species-rich than was originally thought, containing six species that are distributed from the Gulf of St. Lawrence, Canada to the Yucatan Peninsula of Mexico. These species include (from north to south):

- *Mercenaria mercenaria* (Linnaeus, 1758), Gulf of St. Lawrence to North Carolina
- *Mercenaria mercenaria notata* (Say, 1822), North Carolina to Georgia
- *Mercenaria campechiensis* (Gmelin, 1791), New Jersey to the Florida Keys and the entire Gulf of Mexico
- *Mercenaria hartae* Petuch, 2013, coastal lagoons of Martin and Palm Beach Counties, Florida
- *Mercenaria browni* Petuch and Berschauer, n.sp., Ten Thousand Islands of SW Florida
- *Mercenaria texana* (Dall, 1902), coastal lagoons of Texas

ACKNOWLEDGMENTS

We thank the following individuals for helping us with the research that led to the publication of this paper: for the generous donation of type specimens, we thank Damaso Monteiro, Fortaleza, Ceara, Brazil and Oporto, Portugal (*Poremskiconus potiguar*, *Jaspidiconus ramosorum*, *Jaspidiconus serafimi*, and *Jaspidiconus toincabrali*); Rika Goethaels and Fernand De Donder, Peutie, Belgium (*Jaton rikae*); and Marcus and Jose Coltro, Sao Paulo, Brazil (*Jaspidiconus tammymyersae*); and for technical and logistical support in our field work in the Ten Thousand Islands, we thank A. Kenneth ("Kenny") Brown, Jr., Captain Mark Houston Brown, and Captain Craig Marshall Daniels, Jr., all of Chokoloskee Island, Collier County, Florida.

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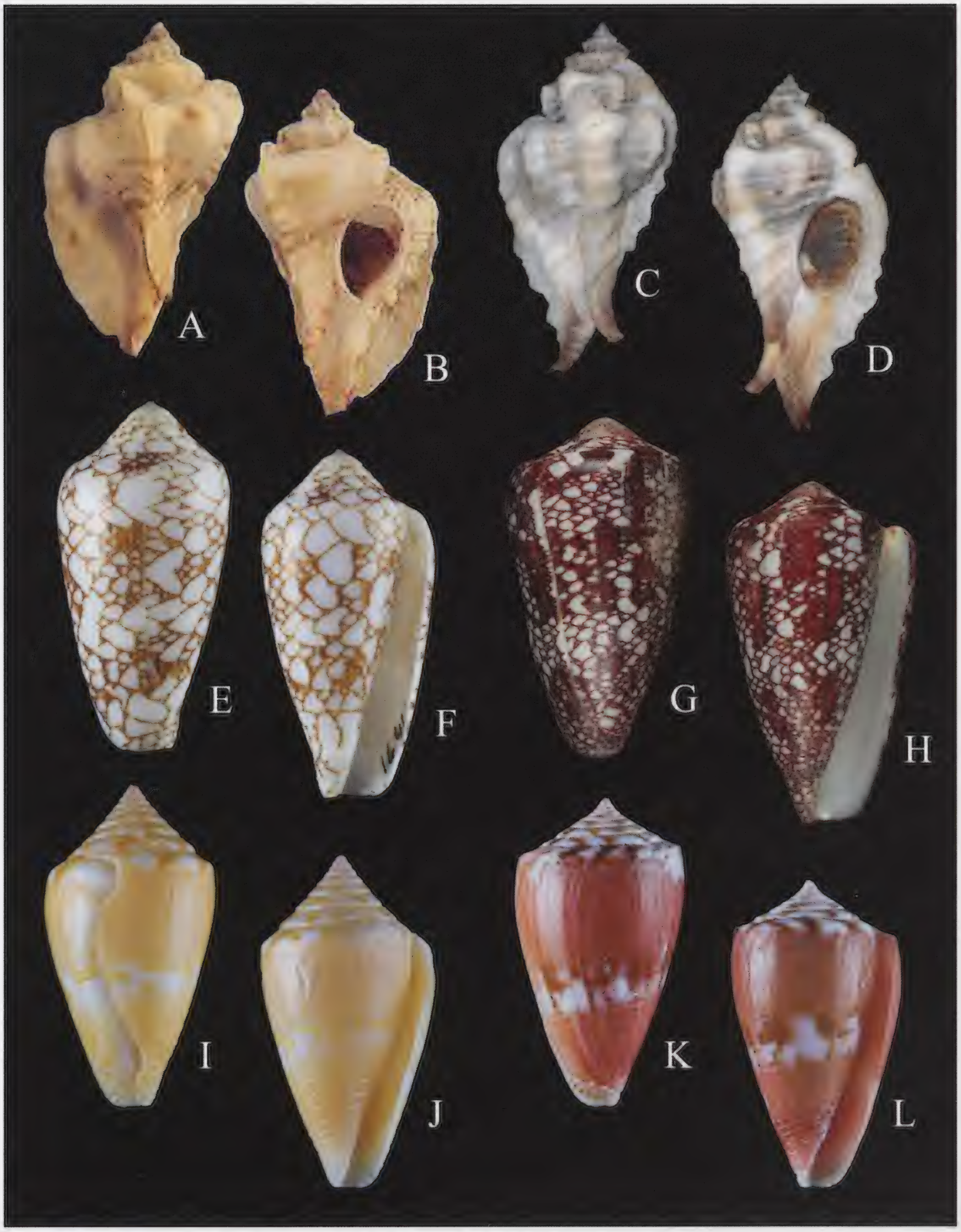

Figure 1. New Species of *Jaton*, *Darioconus*, and *Poremskiconus*.
A, B = *Jaton rikae* Petuch and Berschauer, n. sp., holotype, length 18.7 mm, Gunjur, Gambia; **C, D** = *Jaton hemitripterus* (Lamarck, 1816), length 38.0 mm, Dakhla, Western Sahara; **E, F** = *Darioconus bratcherae* Petuch and Berschauer, n. sp., holotype, length 41.7 mm, Eilat, Israel, Gulf of Aqaba; **G, H** = *Darioconus quasimagnificus* (da Motta, 1982), length 68.5 mm, holotype, Masirah Island, Oman (for comparison with *D. bratcherae*); **I, J** = *Poremskiconus potiguar* Petuch and Berschauer, n. sp., holotype, length 20.9 mm, Tibau do Sul, Rio Grande do Norte State, Brazil; **K, L** = *Poremskiconus mauricioi* (J. Coltro, 2004), length 23.1 mm, Rio do Fogo, Rio Grande do Norte State, Brazil.

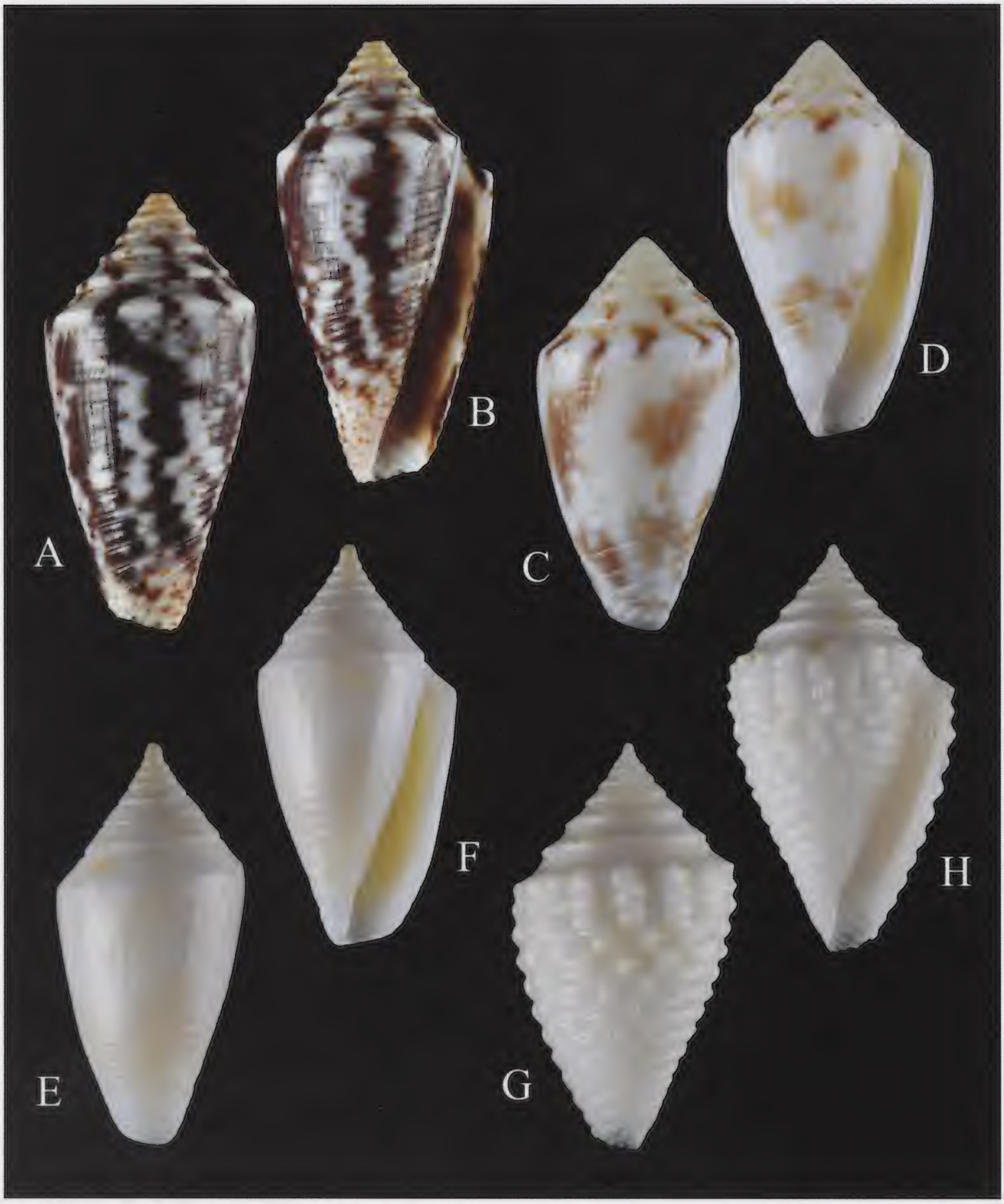

Figure 2. New Species of *Jaspidiconus*.
A, B = *Jaspidiconus ramosorum* Petuch and Berschauer, n. sp., holotype, length 19.8 mm, Abrolhos Platform off Nova Vicosa, Bahia State, Brazil; **C, D** = *Jaspidiconus serafimi* Petuch and Berschauer, n. sp., holotype, length 17.7 mm, Tibau do Sul, Rio Grande do Norte State, Brazil; **E, F** = *Jaspidiconus tammymyersae* Petuch and Berschauer, n. sp., holotype, length 13.3 mm, Little St. James Island, US Virgin Islands; **G, H** = *Jaspidiconus toincabrali* Petuch and Berschauer, n. sp., holotype, length 14.0 mm, Tibau do Sul, Rio Grande do Norte State, Brazil.

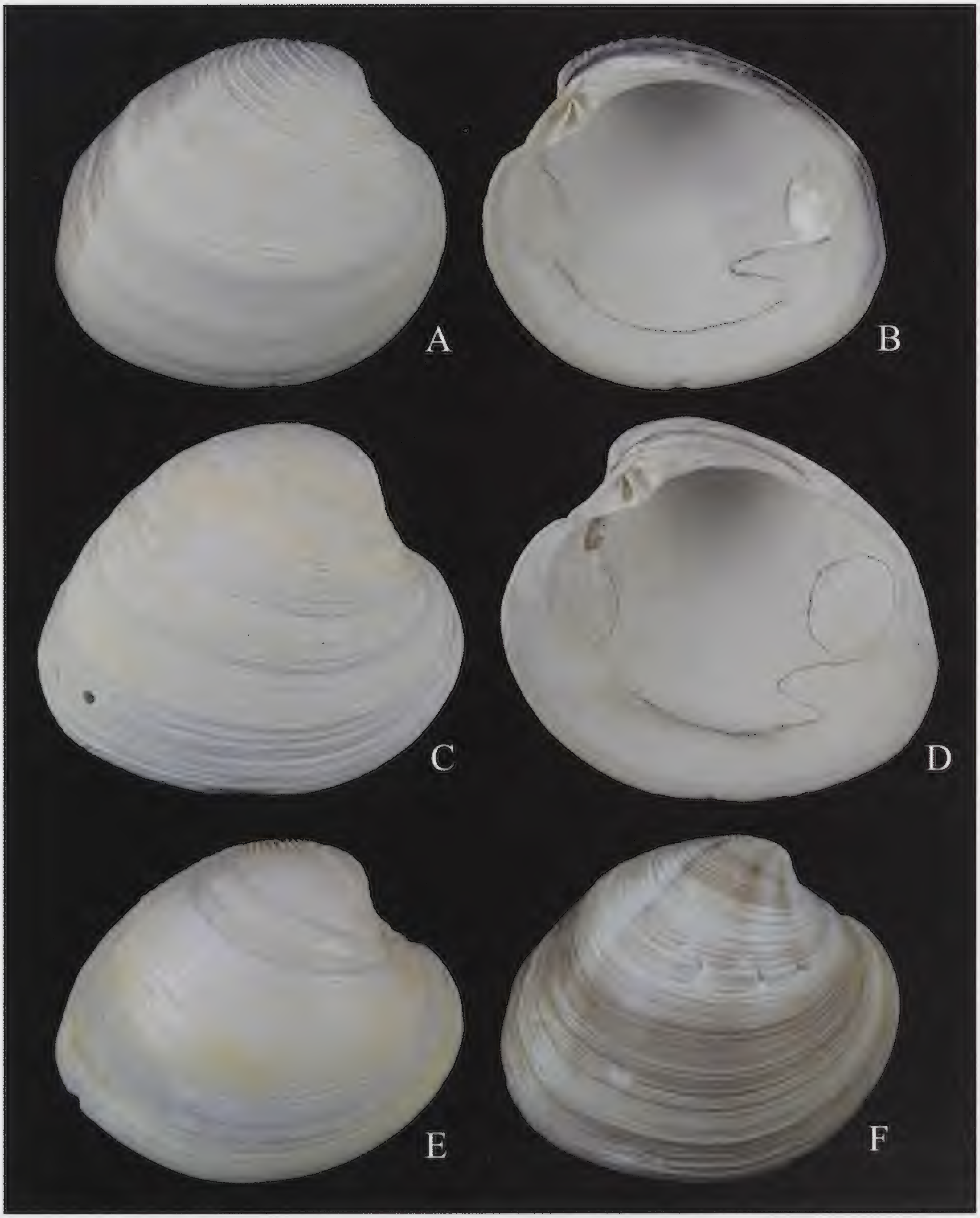

Figure 3. Members of the *Mercenaria campechiensis* complex, and *Mercenaria browni* n. sp.
A, B = *Mercenaria browni* Petuch and Berschauer, holotype, length 71.3 mm, Round Key, Ten Thousand Islands, Collier County, Florida; **C, D** = *Mercenaria campechiensis* (Gmelin, 1791), length 93 mm, Camp Lulu Key, Ten Thousand Islands, Collier County, Florida; **E** = *Mercenaria hartae* Petuch, 2013, length 76 mm, Singer Island, Lake Worth Lagoon, Palm Beach County, Florida; **F** = *Mercenaria texana* (Dall, 1902), length 50 mm, Aransas Pass, Port Aransas, Nueces County, Texas.

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Two new subspecies of *Amphidromus* from Indonesia (Mollusca: Gastropoda: Camaenidae)

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ABSTRACT Two new subspecies of the genus *Amphidromus* Albers, 1850 are described from Indonesia and compared to five other species and subspecies of this genus: *Amphidromus berschaueri* Thach, 2018, *Amphidromus reflexilabris* Schepman, 1892, *Amphidromus laevus janetabbasae* Parsons, 2014, *Amphidromus laevus kissuensis* Rolle, 1903 and *Amphidromus laevus nusteli* Parsons, 2014.

KEYWORDS Gastropoda, Helicoidea, Camaenidae, *Amphidromus*, Ayu Topas, Sei, Kolbano, Lakor, Leti, Moa, Kisar, West Timor, Indonesia, new taxa

INTRODUCTION

Amphidromus is a genus of the family Camaenidae with many species collected in Indonesia. In summer 2018, two other subspecies of this genus were collected. They were not listed in the works by Parkinson, Hemmen & Groh (1987), Abbott (1989), Dharma (2005), Severns (2006), Stanisic, Shea, Potter & Griffiths (2010, 2017), Van der Bijl *et al.* (2010), Schileyko (2011), Tan *et al.* (2011), Parsons (2014), Raheem et al.,2014, Inkhavilay, Sutcharit & Panha (2017), Lok & Tan (2018), Thach (2005, 2007, 2012, 2016, 2017, 2018). In this article, they are described as new to science.

Abbreviations.

FMNH	Field Museum of Natural History, Chicago, USA
RMNH	Naturalis Center of Biodiversity, Leiden, The Netherlands
NNT	Collection Dr Thach
JA	Collection John Abbas
SH	Shell height
SW	Shell width
AH	Aperture height
BH	Body whorl height

SYSTEMATICS

Class Gastropoda Cuvier, 1797
Superfamily Helicoidea Rafinesque, 1815
Family Camaenidae Pilsbry, 1895
Subfamily Camaeninae Pilsbry & Olsson, 1954
Genus *Amphidromus* Albers, 1850
  Type species of genus: *Helix perversus* Linnaeus, 1758 (subsequent designation by Martens, 1896)

Amphidromus berschaueri mingmini
Thach, 2019, new subspecies
(Figures 1-8)

Type material. Holotype 38.7 mm in FMNH (Figures1, 2, 3, 4, 8a, 8b) with Registration No FMNH 386363. Paratypes: All from type locality, Paratype 1: 42.7 mm (Figures 5, 6) and Paratype 2: 40.9 mm (Figure 7) in NNT; Paratype 3: 39.7 mm, Paratype 4: 36.4 mm and Paratype 5: 43.3 mm (not illustrated) in JA.

Type locality. Ayu Topas, West Timor.

Habitat. Around trees.

Diagnosis: The new species is characterized by slender shape, purplish-red subsutural bands, black apex, regularly-spaced axial stripes and columella elevated at anterior end

Description: Shell large for the genus (measuring in height between 34.4mm and 43.3 mm), sinistral, elongate tapering in outline with width 46.7% of height (see Table 1). Spire tall and straight-sided, sutures constricted. Body whorl slightly inflated and measuring 64.2% of shell height, periphery rounded. Outer surface ornamented with widely-spaced axial stripes, extending from suture to suture. Sculpture consists of oblique axial striae and purplish-red subsutural bands. Aperture elongate and occupying 45.3% of shell height, outer lip moderately thick and reflected. Umbilicus open, columella calloused and elevated at anterior part. Color brown with black apex, white outer lip and columella. Type material was provided by John Abbas from Hawaii, USA.

No.	1	2	3	4	5	6
SH (mm)	38.7	42.7	40.9	39.7	36.4	43.3
SW (mm)	17.8	20.1	18.6	18.5	18.0	20.1
SW/SH	0.46	0.47	0.45	0.47	0.49	0.46
Mean SW/SH	**0.47**					
AH (mm)	17.3	19.7	18.2	17.5	17.2	19.0
AH/SH	0.45	0.46	0.46	0.44	0.47	0.44
Mean AH/SH	**0.45**					
BH (mm)	24.1	27.6	26.1	25.0	24.6	27.4
BH/SH	0.62	0.65	0.64	0.63	0.68	0.63
Mean BH/SH	**0.64**					

Table 1. *Amphidromus berschaueri mingmini* Thach, 2019, new subspecies

Etymology. This new subspecies is named in honor of Ming Min from China for his interest at malacological study.

Discussion. The new subspecies is close to *Amphidromus berschaueri* Thach, 2018 (Figures 9, 12) but differs mainly in different localities (Ayu Topas versus Sei, Kolbano), slenderer shape, narrower aperture, longer and more tapering spire, presence of purple-red subsutural bands, widely-spaced (not coalescent) axial stripes at last whorl and columella is angulate (elevated at anterior part). *Amphidromus reflexilabris* Schepman, 1892 (Figures 10, 11) is distinguished mainly from the new subspecies by obese shape, broader and not tapering spire, white (not purple-red) subsutural bands, not regularly-spaced (or lacking) axial stripes at body whorl, more oblique columella and outer lip is purplish (not white), rolled up and forming a tube at dorsal side.

Amphidromus laevus lakorensis Thach, 2019
new subspecies
(Figures 13-18, 20a, 20b)

Type material. Holotype 34.6mm in FMNH (Figures 1, 2, 3, 4, 8a, 8b) with Registration No FMNH 386364.

Other Material Examined. Paratypes: All from type locality, Paratype 1: 38.3 mm (Figures 5, 6) and Paratype 2: 31.8 mm (not illustrated) in NNT; Paratype 3: 49.0 mm, Paratype 4: 37.8 mm and Paratype 5: 35.1 mm (not illustrated) in JA.

Type locality. Lakor Island, West Timor, Indonesia.

Habitat. Around trees.

Diagnosis. The new subspecies is readily recognized by robust shell, lack of axial stripes, constricted sutures, not angulate columella, obsolete (or very few) black lines at body whorl and penultimate whorl is much narrower than last whorl.

Description. Shell large for the genus (measuring in height between 31.8 mm and 49.0 mm), solid, sinistral, elongate tapering in outline with width 51.2% of height (see table 2). Spire tall, sutures constricted. Body whorl inflated and measuring about 69.2% of shell height, periphery rounded. Outer surface ornamented with orange spiral bands at body whorl and blackish (or brownish) spiral lines at spire whorls, axial lines lacking. Whorl diameters decrease abruptly from body whorl to penultimate whorl. Sculpture consists of weak axial striae and growth lines. Aperture elongate, flared anteriorly and occupying 45.5% of shell height, outer lip moderately thick and slightly reflected. Umbilicus widely open, columella slightly curved and highly calloused. Color yellowish at body whorl and whitish at spire whorls with pink early whorls, white aperture, outer lip and columella, pinkish white apex. Type material was provided by John Abbas from Hawaii, USA.

No.	1	2	3	4	5	6
SH (mm)	34.6	38.3	31.8	49.0	37.8	35.1
SW (mm)	17.8	19.6	18.2	21.3	20.0	17.9
SW/SH	0.51	0.51	0.57	0.44	0.53	0.51
Mean SW/SH	**0.51**					
AH (mm)	15.5	18.2	15.1	19.8	17.3	16.5
AH/SH	0.45	0.48	0.47	0.40	0.46	0.47
Mean AH/SH	**0.46**					
BH (mm)	22.5	25.5	21.5	39.9	25.3	23.5
BH/SH	0.65	0.67	0.68	0.81	0.67	0.67
Mean BH/SH	**0.69**					

Table 2. *Amphidromus laevus lakorensis* Thach, 2019, new subspecies

Etymology. This new subspecies is named after the Lakor Island of Indonesia.

Discussion. The new subspecies is close to *Amphidromus laevus janetabbasae* Parsons, 2014 (Figures 19, 21b, 22) but differs mainly in different localities (Lakor Island versus Moa Island), larger adult size, more robust shell, more inflated body whorl, elongate and more tapering spire, more constricted sutures, obsolete (or less numerous) black spiral lines at body whorl, not wavy columella, lack of red spiral band below suture of body whorl, abrupt decrease of diameters from last to penultimate whorl, background color less yellow at body whorl and whiter at spire whorls. *Amphidromus laevus kissiuensis* Rolle, 1903 (Figure 23) is distinguished mainly from the new subspecies by different localities (Kisar Island versus Lakor Island), smaller in adult size, presence of broad, dark-colored and widely-spaced spiral bands at body whorl, black (not pinkish white) apex, shorter spire, less elongate aperture with external pattern visible within. *Amphidromus laevus nusteli* Parsons, 2014 (Figure 24) differs mainly from the new subspecies by different localities (Leti Island versus Lakor Island), smaller in adult size, shorter body whorl, black apex, coalescent spiral bands, yellower background color (especially at spire whorls).

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I express thanks to RMNH and Bijl *et al.* for the photos of *Amphidromus reflexilabris*, to Guido and Philippe Poppe for the photo of *Amphidromus laevus kissiuensis*, to Andy Tan for the photo of *Amphidromus laevus nusteli* and to the reviewers for useful comments.

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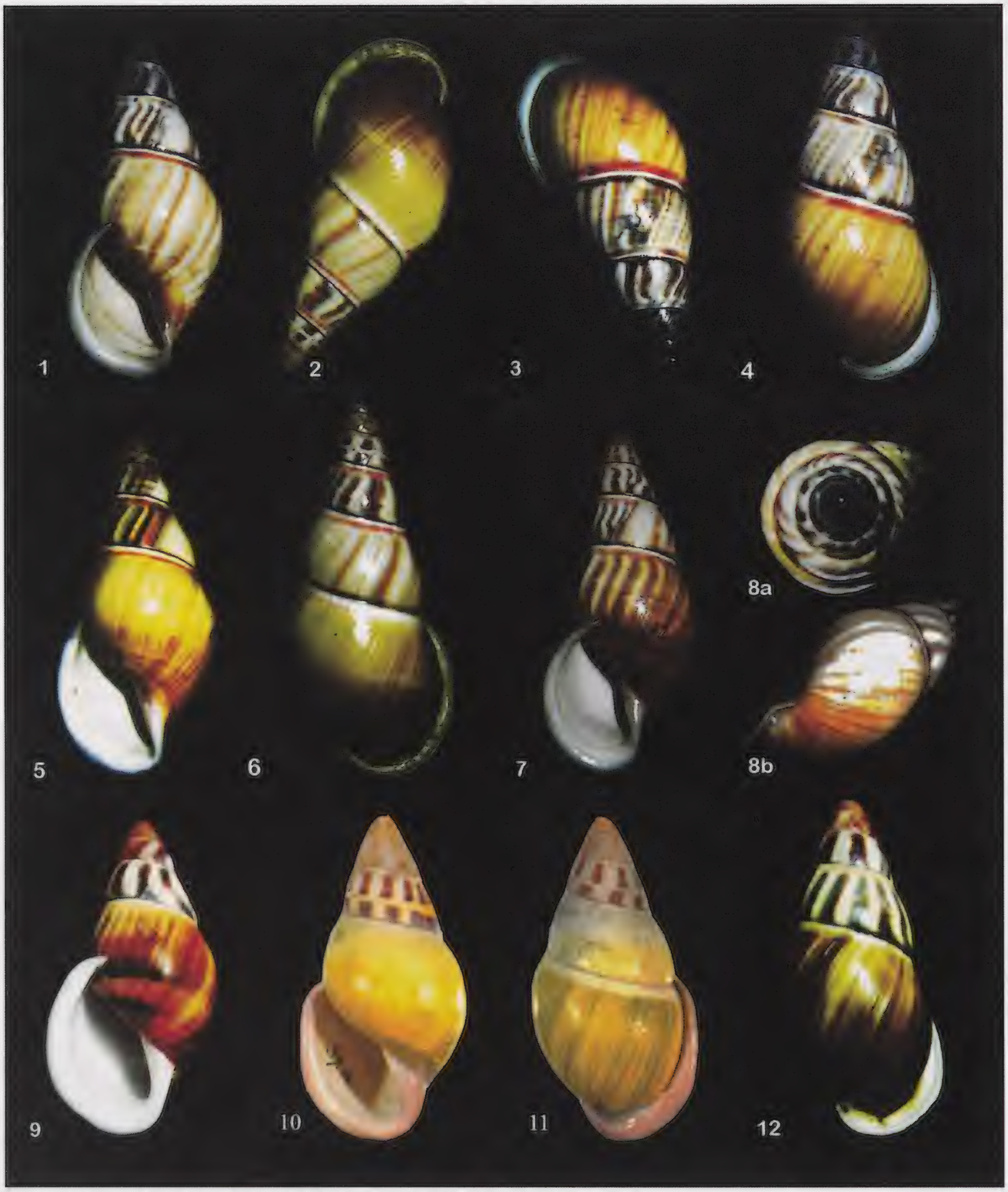

Plate 1. ***Amphidromus berschaueri mingmini*, *A. berschaueri*, and *A. reflexilabris*.**

1-8a, 8b: *Amphidromus berschaueri mingmini* new subspecies, Ayu Topas, West Timor, Indonesia
- **1, 2:** Holotype 44.5 mm with ventral side and reflected outer lip in FMNH
- **3, 4:** Holotype with spire view and dorsal view
- **5, 6:** Paratype 1, 42.7 mm with ventral and dorsal sides in NNT
- **7:** Paratype 2, 40.9 mm with ventral side in JA
- **8a:** Holotype with enlarged apex
- **8b:** Holotype with enlarged umbilicus

9, 12: *Amphidromus berschaueri* Thach, 2018 for comparison
10, 11: *Amphidromus reflexilabris* Schepman, 1892 for comparison, photo of Bijl *et al.*, 2010

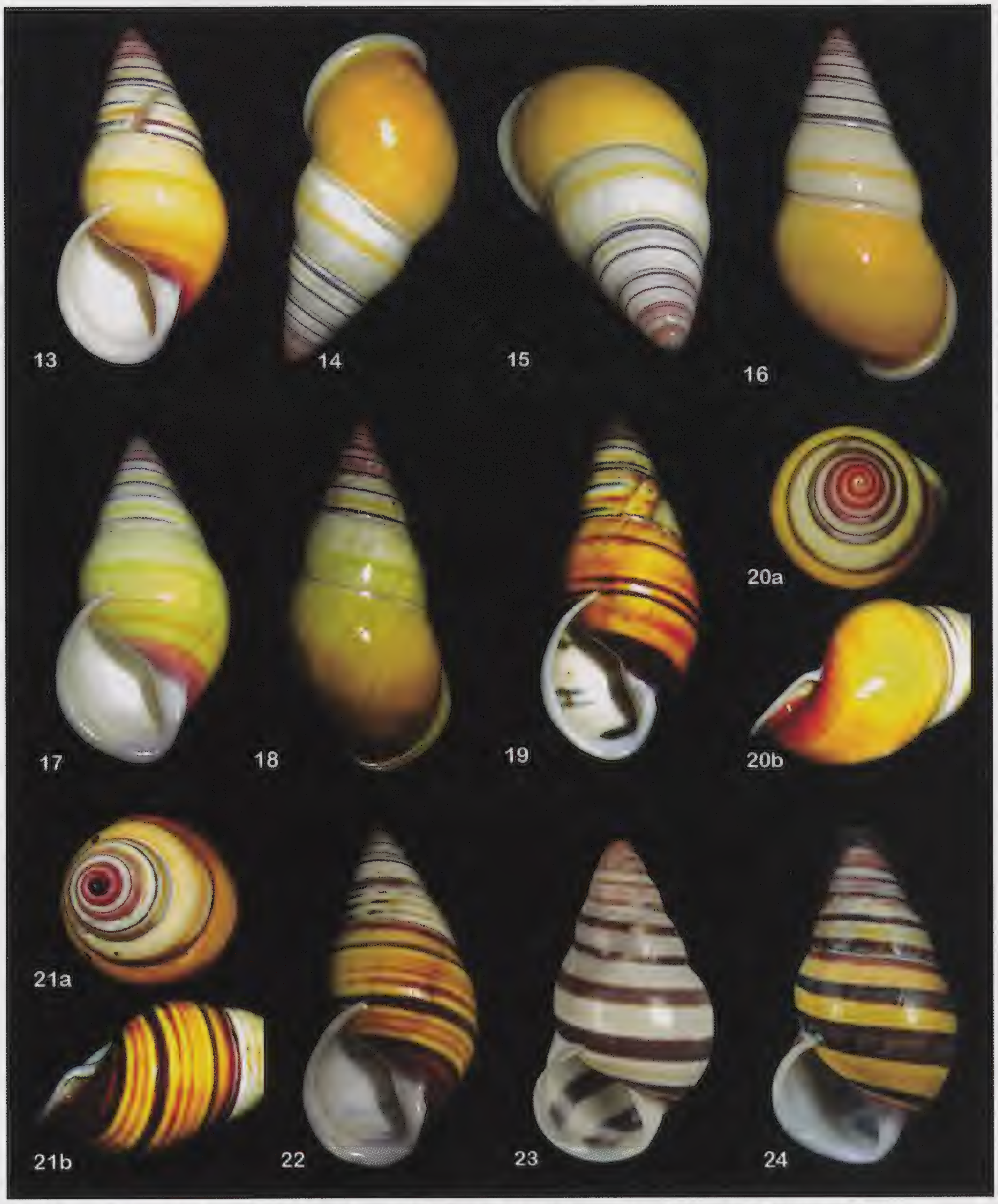

Plate 2. ***Amphidromus laevus lakorensis*, *A. janetabbasae*, *A. laevus nusteli*, *A. laevus janetabbasae*, and *A. laevus kissiuensis*.**

13-18, 20a, 20b: ***Amphidromus laevus lakorensis* new subspecies,** Lakor Island, West Timor, Indonesia

- **13, 14:** Holotype 34.6 mm with ventral side and reflected outer lip in FMNH
- **15, 16:** Holotype with spire view and dorsal view
- **17, 18:** Paratype 1, 38.3 mm with ventral and dorsal sides in NNT
- **20a:** Holotype with enlarged apex
- **20b:** Holotype with enlarged umbilicus

19: ***Amphidromus janetabbasae*** 36.8 mm with ventral side for comparison

21a: Enlarged apex of ***Amphidromus laevus nusteli*** Parsons, 2014, 33.2 mm for comparison

21b: Enlarged umbilicus of ***Amphidromus laevus janetabbasae*** Parsons, 2014, 33.4 mm for comparison

22: ***Amphidromus laevus janetabbasae*** Parsons, 2014, 33.4 mm for comparison

23: ***Amphidromus laevus kissiuensis*** Rolle, 1903, 28.6 mm for comparison, photo of Guido and Philippe Poppe, 2018

24: ***Amphidromus laevus nusteli*** Parsons, 2014, 29.1 mm for comparison, photo of Malacologia-Asia

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The Fossil Cypraeidae of the Golden Gate Member, Tamiami Formation of Southern Florida: (Mollusca: Gastropoda: Cypraeidae)

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ABSTRACT The first tropical hard corals, migrating from the Caribbean, established themselves along the rim of the Everglades Pseudoatoll in the mid to late Piacenzian Pliocene, 3.1-2.6 million years ago (hereinafter "mya"). The rim or perimeter delineated the pseudoatoll, a "U shaped" feature, open in the north, which ran east southeast from the Palm Beach Reef Tract through the Miami Beach Tract, curving to the southwest before linking with the Immokalee Reef Tract on the west coast of present day southern Florida. The pseudoatoll encompassed a very large depressional lagoon. The coral and coralline facies have been designated the Golden Gate Member (Golden Gate) of the Tamiami Formation. The Lower, Middle, Upper and Uppermost beds are equivalent in time with the Pinecrest and the Fruitville Members of the Tamiami Formation, with the middle and upper layers thickest as the warming of southern Florida progressed to its maximum during Fruitville time. Nine Cypraeidae species in three genera have been recorded from the Golden Gate: one in the Lower beds, three in the Middle beds, three in the Upper beds and two in the Uppermost beds. The pseudoatoll corals, coral reefs and associated molluscan fauna became extinct as the result of a catastrophic extinction event caused by rapid and severe cooling during the Piacenzian Pliocene and Gelasian Pleistocene crossover period, circa 2.6 mya. This event also marks the end of the Tamiami Formation.

KEYWORDS Peninsular Florida, Everglades Pseudoatoll, Tamiami Formation, Golden Gate Member (Golden Gate), Lower Beds, Middle Beds, Upper Beds, Pinecrest Member, Fruitville Member, Cypraeidae, fossil, *Akleistostoma*, *Siphocypraea*, *Pseudadusta*, Myakka Lagoon System (Myakka), Sarasota, Polk Peninsula, Kissimmee Embayment, Kissimmee River Valley (Kissimmee), Caloosahatchee Strait, Loxahatchee Strait

INTRODUCTION

Peninsular Florida - Everglades Pseudoatoll

In the late Eocene, 35.5 +/- 0.3 mya, a giant meteor impacted at what is today the mouth of the Chesapeake Bay of Maryland. The impact caused a series of giant tsunamis, estimated as high as 300+ meters, to spread out from the center of the impact. These would have swept over the entire bedrock Florida Platform which underlies peninsular Florida, that was not as yet emergent. These tsunamis would have scoured the sea bottom of unconsolidated sea floor sediments, including the area which was to become the Everglades Pseudoatoll. The scouring is the probable cause of the Everglades Unconformity. An unconformity is a type of discontinuity whereby layers of rocks between older and younger strata are missing due to erosion or the lack of sediment deposition over an extended period of time. The unconformity dates to the end of the Ocala deposition, which is entirely missing in southern Florida and aligns with the age of the Chesapeake Bay impact.

While these tsunamis would account for the unconformity, they would not account for the lithological and geological formation of the Pseudoatoll. Unlike true atolls which are formed around sinking volcanic islands, there is no such volcanic activity in southern Florida which would account for its formation. Rather, the lithology underlying the pseudoatoll requires an alternative explanation. Unlike the older Eocene formations in central and northern Florida, which are characteristically composed of limestone with small stringers of gypsum and anhydrite (calcium sulphates) in the deep subsurface, the pseudoatoll lithofacies are replaced by fractured and vuggy (hollow cavity) dolostone (carbonate) – limestone facies which have formed fractured boulder zone areas. In addition, there is a small magnetic anomaly within a valley-like depression under the southern Everglades. This steep, high magnetic anomaly is surrounded by a low magnetic area which extends 300+ km to the south and west and 200+ km to the north and east (Klitgord *et al.*, 1984).

A possible explanation lies with the Chesapeake Bay meteor, considered a bolide meteor, *i.e.* a fireball and large impactor. The meteor entered the earth's atmosphere over the north pole and fragmented with the Chesapeake Bay impact fragment being the largest. Secondary fragments and debris spread southward, hitting all along the eastern United States and as far south as Argentina. The southern Florida platform would also have been impacted. The valley-like depression in the southern part of the present day Everglades National Park suggests a hit from a small impactor at a then depth of 250-300 m. This could account for the crater like feature and the fragmenting of the underlying limestone, to a depth of eight kilometers. Following and probably the result of the meteor impact, the Northern Hemisphere experienced a four million year ice age that dropped southern Florida sea levels 200-300 m, resulting in land exposure over the entire Florida Platform.

In the area of the Everglades Unconformity, ground water would have penetrated the fractured limestone and dissolved its smaller fragments, leaving only limestone boulder zones in place. As a result, the surface would have collapsed over time producing a relatively shallow, irregular oval depression which extended northward and is known as the Everglades Depression. It was deepest at the possible southern impact area.

As temperatures and sea levels rose, two banks formed along the southeastern and southwestern higher edges of the depression. These were the precursor to the Everglades Pseudoatoll. As sea levels continued to rise, similar banks progressed northward along the rims of the depression, ultimately resulting in the Pseudoatoll. However, the Pseudoatoll was not a static feature. Climate and sea level changes produced the growth, erosion and even collapse of certain features. Ultimately, tropical hard coral reefs, reef tracts and coralline habitats emerged in full force, reaching their maximum development during the mid to late Piacenzian Fruitville time as the warming of southern Florida also reached its maximum, producing the richest tropical hard coral fauna ever found in the Western Atlantic. Most of the Pseudoatoll coral species also occur in the Gatunian (Caribbean) Province, adjacent to the south. This indicates that they had migrated northward from the Caribbean Region.

By Golden Gate time, mid to late Piacenzian Pliocene (c. 3.1- 2.6 mya), the pseudoatoll was open in the north. Its "U-shaped" perimeter was bounded on the east southeast, south of the Kissimmee River Valley, by the Palm Beach Reef Tract with the Miami Reef Tract representing a continuation of the former, curving to the southwest along the southeast of the pseudoatoll. Along present day southeastern Florida, the coastal cities from Palm Beach to Miami sit atop this rim. The pseudoatoll was bounded on the west by the Immokalee Reef Tract, a broad, zonated reef system which ran south southeast from below the Myakka Lagoon System and encompassed a large chain of carbonate islands. The Long Pine Key Reefs, a set of small reefs, ran from west to east between the southernmost tips of the Immokalee and Miami Reef Tracts. The pseudoatoll was separated from the Kissimmee River Valley and Myakka Lagoon System by the Loxahatchee Strait in the east and the Caloosahatchee Strait in the west.

The lagoon within the pseudoatoll was dominated by the broad, shallow, quartz sand and carbonate Hendry Platform which fronted the leeward side of the Immokalee Reef tract to its east. The platform extended eastward to south of Lake Okeechobee. There, its termination is marked by the north-south running West Everglades Reef chain where it sloped into the deep water Loxahatchee Trough. The trough fronted the leeward side of the two eastern reef tracts and dominated that section of the lagoon.

DISCUSSION

Golden Gate Time

Following a drop in sea levels that presaged the mid-Piacenzian Pliocene (c. 3.1 mya), southern Florida commenced a warming trend, which progressively produced the warmest and most tropical conditions of the entire Pliocene. This was manifested in rising sea levels, the expansion of sea grass bed habitats and mangrove forests and, in the Kissimmee River Valley, the formation of the mud and clay sedimentary strata. The Golden Gate Member of the Everglades Pseudoatoll saw the commencement of the richest tropical, hard coral fauna ever found in the Neogene western Atlantic. In addition to coral reef and coralline habitats, the pseudoatoll hosted shallow sea floors, sea grass beds and mangrove tree forests.

The Golden Gate is contemporaneous with both the uppermost Pinecrest Member and the younger Fruitville Members within the Piacenzian Pliocene Tamiami Formation of southern Florida.

Golden Gate Member, Tamiami Formation

In 1987, Meeder, in an unpublished doctoral dissertation, mapped the wide, zonated coral reef complexes, lithothology and faunal composition of Collier and Lee Counties. This was a more complete survey of the same subject published in 1980. In 1984, Swayze and Miller's survey showed that the reefs under Miami were a continuation of a reef system that extended into northern Palm Beach County. In 1985, Petuch was notified that fossil corals and mollusks were being discovered at a housing development west of Miami on Bird Road (Lakes of the Meadows). These fossils, especially corals, were very similar to those found by Meeder in Collier County. In 1986, Petuch published this data, incorporating both Meeder's and Swayze and Miller's findings. In 1992, Missimer resurrected "Golden Gate Reef" from Meeder's unpublished dissertation and gave it member status. Golden Gate refers to the Golden Gate housing development at the old Mule Pen Quarry, Naples, Florida. The name has been shortened to Golden Gate Member and encompasses the coral reefs, reef tracts and coralline limestones that surround the Everglades basin.

The areal distribution of the Golden Gate Member follows the shape of the reef tracts of

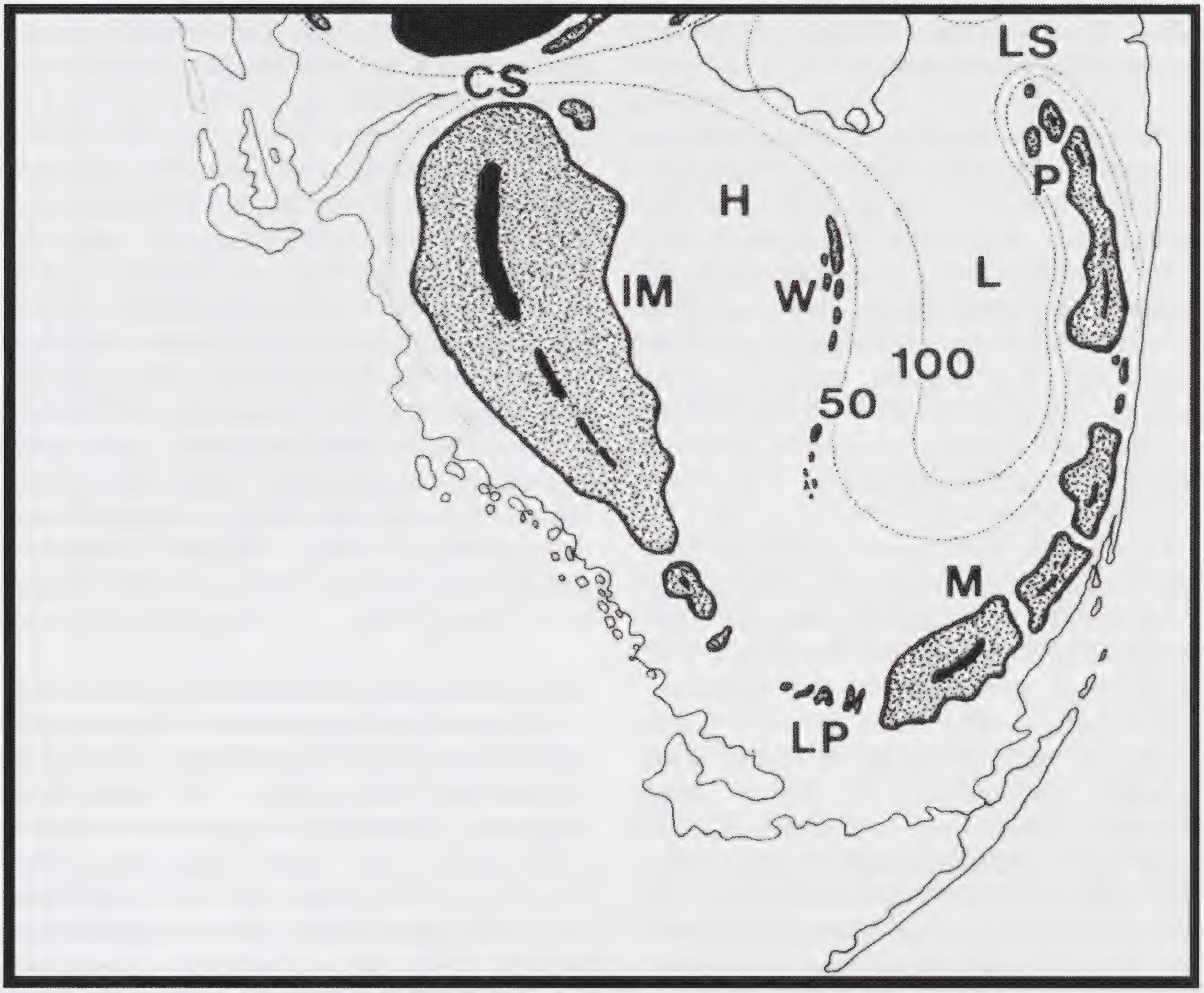

Figure 1. Map reflecting the Everglades Pseudoatoll. CS = Caloosahatchee Strait; LS = Loxahatchee Strait, H = Hendry Platform, IM = Immokalee Reef Tract, W = West Everglades Reef Tract, L = Loxahatchee Sound, M = Miami Reef Tract, LP = Long Pine Reefs. Contours in meters below mean Pliocene sea level. Adapted from Petuch *et al.* 2018, figure 1.5 at p. 37.

The Everglades Pseudoatoll. In the west, member thickness varies from 15 m to 5 m in Collier County. The member is 5 m below the surface at the old Mule Pen Quarry. In the east, the thickness is over 50 m under the Atlantic Coastal Ridge. The facies consist of interspersed (interbedded) highly fossiliferous limestones, including mostly unconsolidated layers of carbonate grains (dolomite silts) and cemented corals (calcilutites), highly porous, vuggy limestone molds, and limestone containing densely packed fossil corals and mollusks intermixed. Small amounts of quartz sand are present in some of the facies.

Of note, sand flats covered with sea grass, as well as mangrove forests, also interfingered with the reefs and reef tracts in the pseudoatoll providing substantially the same habitats as the Myakka Lagoon System and the Kissimmee River Valley to the north.

Golden Gate Member (Lower, Middle, Upper and Uppermost Beds)

The Golden Gate contains four depositional beds. They correspond in time to the uppermost Pinecrest Member (Lower), and Fruitville Members Unit 4 (Middle), Fruitville Unit 3 (Upper) and Fruitville Unit 2 (Uppermost), *in seriatim* oldest to youngest. These are time equivalents, not member equivalents. The Golden Gate is a separate Member. Fossil Cypraeidae collected in the pseudoatoll from other than coralline habitats belong to either the Pinecrest or Fruitville Members.

The Golden Gate beds form a continuum from Lower through Uppermost beds without any defining breaks or separation between them. Assignment of individual bed levels has been done thorough Index fossils. Index fossils are fossils which have a short vertical range indicating a narrow range in time, wide geographic distribution and exhibit rapid evolutionary trends. They are used to define, identify and correlate geologic and/or faunal strata. The Piacenzian molluscan fossils of southern Florida meet the criteria and represent ideal Index fossils with the Cypraeidae, *Hystrivasum*, *Strombus* and *Chicoreus* being particularly useful.

Portions of the Lower (basal) Beds of the Golden Gate were exposed at both the Bird Rock development west of Miami and in Collier County on the west coast. These showed that the tropical, hard coral reefal deposition began in the early middle Piacenzian time, c. 3.1 mya, and was contemporaneous with the uppermost Pinecrest Member. The Bird Rock site contained many classic Pinecrest fossils, *e.g. Hystrivasum olssoni* (Hollister, 1971) from Kissimmee Pinecrest facies, but only one Cypraeidae species. *Akleistostoma (Mansfieldicypraea) miamiensis* Petuch and Drolshagen, 2011 was the first Cypraeidae species associated with coralline environments in the Golden Gate.

The Golden Gate reached its maximum development in the mid to late Piacenzian, *i.e.* Fruitville Time. While there is no clear delineation of the beds above the base, the recording of *Siphocypraea (Seminolecypraea) grovesi* Petuch, 1998 in both Fruitville Member Unit 4 at the Quality Aggregates Pit in Sarasota and the old Mule Pen Quarry, Naples, Florida, allows a Middle Beds assignment of the fossil Cypraeidae recorded within similar strata. Other Index Fossils recorded in Unit 4 at Sarasota and the Golden Gate include *Strombus sarasotaensis* Petuch, 1994 and *Hystrivasum lindae* Petuch, 1994.

The recording of *Pseudadusta ketteri* (Petuch, 1994) in both Fruitville Member 3 at the APAC Pit in Sarasota and in the quarries at both Bonita Springs and Naples allows an Upper Beds assignment of the fossil Cypraeidae recorded within similar strata in the Golden Gate. Other Index Fossils recorded in Unit 3 at Sarasota and the Golden Gate include *Chicoreus miccosukee* Petuch, 1991 and *Pterorhytis squamulosa* Petuch, 1994.

No Golden Gate restricted fossil Cypraeidae from the Uppermost beds have been recorded in equivalent units. However, other Index fossils, such as *Hystrivasum hertweckorum* Petuch, 1994 and *Chicoreus judeae* Petuch, 1994, have been recorded from Unit 2 at Sarasota and in the Golden Gate. This allows an Uppermost beds assignment to the Cypraeidae recorded within similar strata.

Extinction event

The intervals between successive Fruitville Member units represent periodic molluscan impoverishment events which are also reflected in the Kissimmee River Valley Equivalent Units and the Golden Gate beds. These events were relatively short lived and temporary in nature, although specific species, including Cypraeidae, disappeared from the collecting sites available to modern day collectors. Their continued isolated presence is inferred by renewed speciation and radiation once climatic conditions once again became supportive. However, in the late-Piacenzian, following Unit 2 and Golden Gate equivalent time (Uppermost beds), during the Piacenzian, Pliocene and Gelasian Pleistocene crossover period, c. 2.6 mya, there occurred the first of a two stage catastrophic extinction event that permanently altered both the geology and the habitats of molluscan populations.

As a result of a period of cooling prior to Unit 2 time, sea levels had already dropped resulting in more diverse and isolated habitats. The brief warming that followed brought little respite to the reduced molluscan populations, severely limiting renewed speciation and radiation. This wounding event was closely followed by a major extinction event, the first stage of the two stage event, caused by rapid and severe cooling that resulted in the catastrophic extinction of the pseudoatoll corals, coral reefs and the associated molluscan (Cypraeidae) populations. The Myakka and Kissimmee sea grass beds, mud flats and mangrove forests also fell victim to this catastrophic event with the *Akleistostoma*, *Calusacypraea* and *Pseudadusta* genera becoming extinct. Lastly, this event marks the end point of the Tamiami Formation.

Golden Gate Member Cypraeidae

Golden Gate Cypraeidae species inhabited coral reef lagoon back reef areas consisting of dense beds of solitary cup (*Antillia* Duncan, 1864, now *Trachyphillia* Milne Edwards & Haime, 1849) and rose (*Manicina* Ehrenberg, 1834) corals which were embedded in carbonate sand and mud. These interfingered with small open sand patches covered in sea grass. Together, they appear to have formed the habitats for the species listed below as some specimens collected are encased to some extent in coral while others are not. Altogether, nine species in three genera have been collected in Golden Gate deposits.

- Uppermost coral beds (Fruitville Unit 2 equivalent Time)
  - *Siphocypraea (Lokossea) mulepenensis* Petuch, 1991 (Figure 2A)
  - *Pseudadusta roachi* Petuch and Drolshagen, 2011 (Figure 2B)
- Upper coral beds (Fruitville Unit 3 equivalent Time)
  - *Pseudadusta collierensis* Petuch and Drolshagen, 2011 (Figure 2C)
  - *Pseudadusta fehsei* Petuch and Drolshagen, 2011 (Figure 2D)
  - *Pseudadusta ketteri* (Petuch, 1994) (Figure 2E)
- Middle coral beds (Fruitville Unit 4 equivalent Time)
  - *Siphocypraea (Seminolecypraea) grovesi* Petuch, 1998 (Figure 2F)
  - *Pseudadusta (Bithloa) irisae* Petuch and Drolshagen, 2011 (Figure 2G)
  - *Pseudadusta lindae* (Petuch, 1986) (Figure 2H)
- Lower coral beds (Uppermost Pinecrest equivalent Time)
  - *Akleistostoma (Mansfieldicypraea) miamiensis* Petuch and Drolshagen, 2011 (Figure 2I)

Table 1. Golden Gate Member depositional beds and their respective Cypraeidae species.

Origins

Five of the six species of the subgenus *Akleistostoma (Mansfieldicypraea)* Petuch and Drolshagen, 2011 have been recorded exclusively from the west coast Sarasota quarries. Only *A. (M.) miamiensis* has been recorded from the east coast lower beds at the Bird Rock development west of Miami. It can be considered a relictual species. The species possess larger and more developed aperture dentition and better developed auricles. From the dorsal aspect, all six species bear a resemblance to *Akleistostoma carolinensis* (Conrad, 1841) and are probably evolutionary offshoots of that widespread species.

Recorded from both the Sarasota quarries and the coralline middle beds old Mule Pen Quarry in Naples, *S. (S.) grovesi* is most similar to the older *Siphocypraea (Seminolecypraea) trippeana* Parodiz, 1988, its probable ancestor. *Pseudadusta lindae* has been recorded from both the Bird Rock development and more commonly from the west coast coralline quarries at Bonita Springs and Naples. Its ancestor is unknown. The elongated *P. (B.) irisae* has only been recorded from the west coast coralline quarries, its ancestor is also unknown.

Recorded from both the Sarasota quarries and the coralline upper beds at west coast quarries, *P. ketteri* resembles an elongated *P. lindae*, its probable ancestor. Both *P. collierensis* and *P. fehsei* have only been recorded from the west coast coralline quarries. The former resembles a smaller and more rotund *P. lindae*, its probable ancestor, while the latter resembles a larger, more inflated *P. (B.) irisae.* However, its ancestor is unknown.

Recorded from the uppermost beds of the west coast quarries, *P. roachi* also resembles *P. lindae* which probably served as an ancestor to a number of species (see above). The large and globular *S. (L.) mulepenensis* resembles a much more globular *Siphocypraea cannoni* Petuch, 1994, a possible ancestor.

Note: Due to the very limited number of quarries and collecting sites located on the east coast reef tracts as well as the depth of the Golden Gate in those areas, the molluscan fauna, including the Cypraeidae, have been poorly sampled. While the west coast quarries have offered better access in past, the quarries (mostly closed at present) were still limited in number. More extensive access to the Golden Gate would probably show more extensive species distribution than is presently known.

For detailed genera and species descriptions, background information and discussion, see Jewels of the Everglades, The Fossil Cowries of Southern Florida, 2018, by Edward J. Petuch, David P. Berschauer, and Robert F. Myers.

ACKNOWLEDGEMENTS

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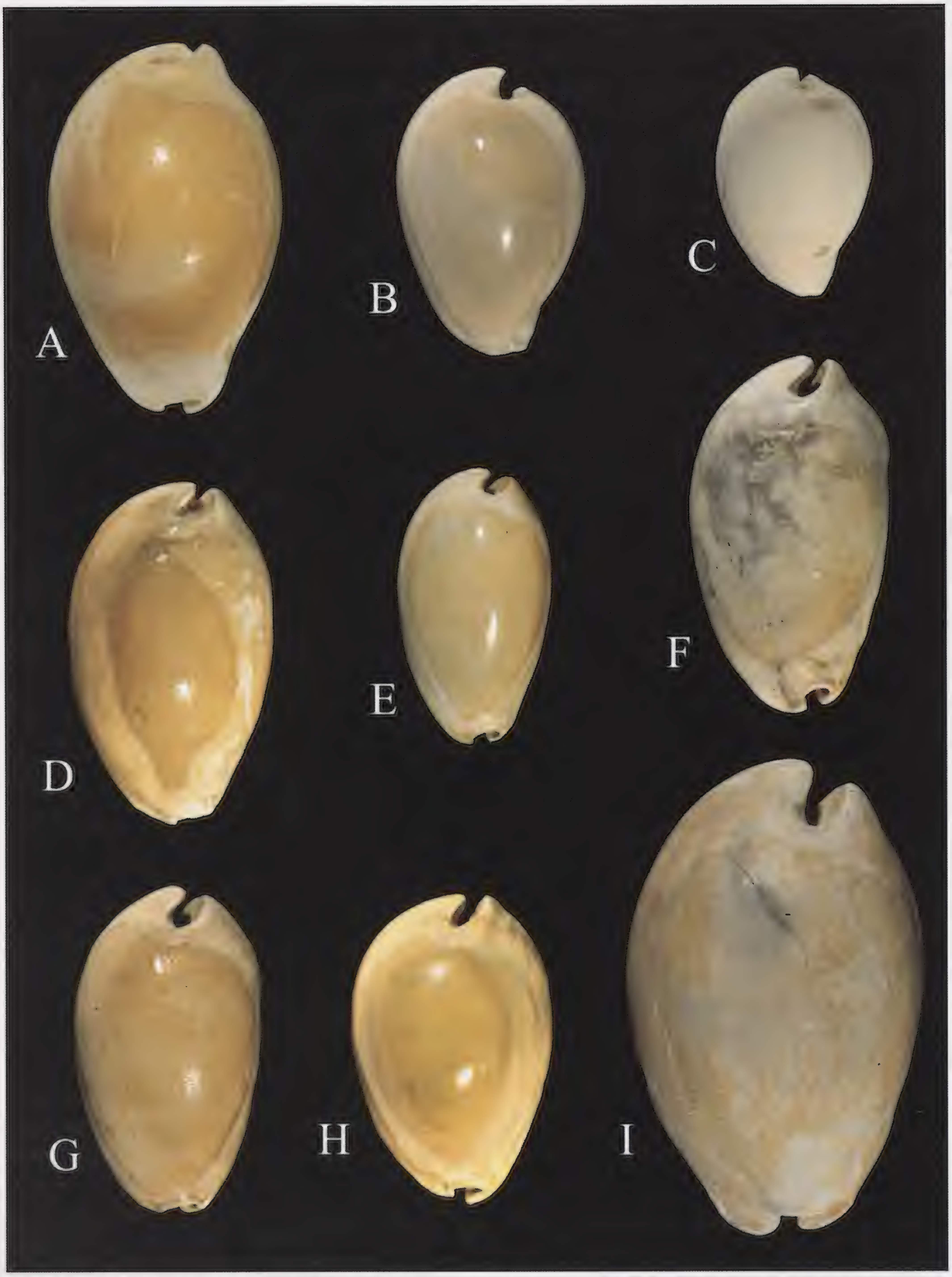

Figure 2. Golden Gate Member Cypraeidae. **A** = *Siphocypraea (Lokossea) mulepenensis* Petuch, 1991, 66.7 mm; **B** = *Pseudadusta roachi* Petuch and Drolshagen, 2011, 52.2 mm; **C** = *Pseudadusta collierensis* Petuch and Drolshagen, 2011, 42.2 mm; **D** = *Pseudadusta fehsei* Petuch and Drolshagen, 2011, 63.2 mm; **E** = *Pseudadusta ketteri* (Petuch, 1994), 50.1 mm; **F** = *Siphocypraea (Seminolecypraea) grovesi* Petuch, 1998, 64.7 mm; **G** = *Pseudadusta (Bithloa) irisae* Petuch and Drolshagen, 2011, 60.0 mm; **H** = *Pseudadusta lindae* (Petuch, 1986), 56.0 mm; **I** = *Akleistostoma (Mansfieldicypraea) miamiensis* Petuch and Drolshagen, 2011, 87.1 mm.

Have a shell collection you would like to donate to The San Diego Shell Club?

The San Diego Shell Club is interested in your shell collection. As a 501c(3) organization, all donations to our Club may provide a tax write-off. When we receive a donation we provide a letter describing the items that may be used when filing your taxes. While we cannot provide a value, donations of up to $5,000 do not require a written appraisal. Since tax laws change regularly we recommend that you check with your tax accountant before relying on any information provided here.

We are interested in all types of shells, marine or land and all genera and species, including books on shells as well as items related to shells such as artwork, storage cases and tools. Your donated items will be used to generate income to support the Club's efforts in continuing Public education about shells and conservation of marine life throughout the world. If you would like to donate, please contact David Waller, SDSC Acquisition Chairperson, at dwaller@dbwipmg.com to schedule a time to discuss charitable gifting.

CLUB NEWS

2019 May General Meeting

Our May general meeting was held on May 18, 2019, at Leo Kempczenski's home in Tustin. We had a good turn out with members from several counties present, and a wonderful spread of food and drink provided by members. There were also shells for show, trade and sale. David Berschauer gave a presentation on the *Voluta polypleura - demarcoi* complex from off the coast of Honduras. See the article on these interesting volutes on page 184.

2019 June - San Diego County Fair

Our June event was to be a tide pool field trip, however it was canceled due to lack of members expressing an interest in participating. The only Club event in June was the San Diego County Fair. See the article on page 256 for more details.

2019 July - Shell Bazaar

Our Club's annual shell bazaar was held on July 20, 2019, at Dennis and Laura Willoughby's beautiful home and backyard palm oasis in San Diego. We had a good turn out with over 15 members from both San Diego and Orange county, and a wonderful spread of dishes provided by members. There were several tables full of shells for show, trade and sale, as well as our Club table with books, magazines, mugs and pins available.

Beachcombing in Imperial Beach

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Figure 1. **A** - The Spirit of Imperial Beach, **B** - Imperial Beach Boardwalk, **C** - Imperial Beach Pier and **D** - Bibbey's Shell Store.

Prologue: Many of you know me as a collector of specimen shells, mostly *Cypraea*, as I have been for about 15 years. It has been a challenge finding and acquiring what I believe are some of the best specimens shells available through online auctions and from dealers. The first few years were exciting when I was filling out my collection with the more common species, but over time it has become less so because the rarer shells are more difficult to find and relatively expensive. Recently, I was asked to write an article about my beach combing efforts in Imperial Beach, collecting shells for a friend. This didn't really spark my interest. However, I made it a challenge by seeing how many species I could find and identify using the San Diego Shell Club's new publication, Seashells of Southern California - Marine Shells of the Californian Province, (hereinafter "SSSC") by D. Berschauer and R. Clark, 2018. This book proved to be invaluable to my efforts.

Imperial Beach is a beautiful town and I consider myself lucky to spend the time that I have on their beaches. The first couple days of beach combing were spent collecting the more obvious larger shells;

mostly bivalves. Since my collection has very few bivalves, they all pretty much looked the same to me. Consequently, I did my best to identify them. I was surprised to see how many different species occur in Imperial Beach. With this new knowledge, I started looking for the smaller bivalves, and in doing so, began finding other types of shells that I hadn't seen earlier. After a few more identification sessions, I saw shells in the book that I hadn't collected as yet and began looking specifically for them. Following a couple more identification sessions and much to my surprise, I had found some shells that weren't in the book. I caught the beach combing "shell bug." Soon I was crawling on my hands and knees looking for those other unlisted species. My conversion to being a beach comber was a slow evolution starting with a mundane task (or what I had originally considered mundane) of collecting shells on the beach, and leading to what became an exciting journey of exploration. It was my hope of finding that rare and unknown shell that had turned my walks on the beach into exciting adventures. It may not come as a surprise, but my friend who I was collecting shells for is David Berschauer - the same person who asked me to write an article for this journal.

For those who are not familiar with Imperial Beach it is a small beach community bordered by Mexico to the South, the San Diego Bay National Wildlife Refuge to the north and Interstate 5 to the east. When you first enter town (heading west on Palm Avenue) you can see "The Spirit of Imperial Beach"; an eighteen foot bronze sculpture that honors the city's surfing culture and lifeguards who protect the beaches (Figure 1A). The iconic statue, created by James Wasil, was erected in 2008 and is a welcome sentinel to Imperial Beach. After turning south on Seacoast Drive and traveling about a quarter mile you will see the pier erected in 1989 and one of the most notable landmarks in Imperial Beach (Figure 1C). This is, in fact, the town's third pier. The first built in 1909, known as the Edwards Wave Motor Pier, housed a large wave motion generator that supplied the small town of Imperial Beach with electricity. This pier partially collapsed in 1949 from age, receiving its final blow from a high tidal storm surge in January 1953. The pier was eventually rebuilt in 1962 but a series of winter storms in 1980, 1983 and 1986 severely damaged the structure, which was later replaced with the pier we see today. Across from the pier you will find "Bibbey's Shell Shop" one of the last remaining shell stores in San Diego (Figure 1D). Opened by Joe Bibbey in 1984, it is now run by his son Michael since 2000. I recommend a quick look inside before continuing your journey. As you travel through town passing Imperial Beach Blvd. you will see on your left the National Estuarine Research Reserve (Figure 2). Formerly known as the Tijuana Slough National Wildlife Refuge when the 500 acre wetland was first acquired by the U.S. Fish and Wildlife Service in 1980, it quickly became part of the U.S. Department of Commerce's National Estuarine Sanctuary Program in 1982 and was renamed the National Estuarine Research Reserve (NERR). In 2005, NERR was designated a "Wetland of International Importance" by the United Nation's Ramsar Convention on Wetlands. For those of you who are naturalists, this is an excellent place to look for the rare and endangered California least tern, Belding's Savanna Sparrow and/or Ridgway's Rail (formerly Clapper Rail). On the east side of NERR is an air strip that has given Imperial Beach the unique title of "Helicopter Capitol of the World". This is the Naval Auxiliary Landing Field designated an Outlying Field (OLF IB) just to the south of town (Figure 3). Formerly established as the Army "Aviation Field" in 1917 and renamed Ream Field to honor Army Major William Roy Ream in 1918, it now operates as a branch of the NAS North Island Naval station handling the overflow helicopter traffic from North Island. While walking on the beach you can often see Sea Hawk helicopters lifting off, circling overhead and landing at Ream Field.

Figure 2. NERR Visitor Center.

Figure 3. Ream Field (OLF IB).

Seacoast Drive continues south along the western edge of the Reserve for another half mile or so terminating in a cul-de-sac with beach access and parking available on the Reserve side of the street. During low tide, I usually begin beach combing from this access point traveling south about a mile to the mouth of the Tijuana River (Figures 4 A-D, and 5 though 8). Just off shore of this strip of beach is the Tijuana River Mouth State Marine Conservation Area established in January 2012 and is the protected resource that supports the Tijuana River Estuary marine ecology. It is important to note that while the ocean current along the coast of California generally flows from north to south on a global scale, regional currents can vary and are affected by tidal flow and weather conditions (Figure 9). Consequently, it is possible to find shells on the beach that are common to the brackish water of NERR as a result of regular tidal flushing. In addition, because the water from the river may be contaminated, it is best to check the County of San Diego Beach Water Quality website located at www.sdbeachinfo.com before you decide to collect shells on the beach. I recommend using latex gloves and reach extender or grabber arm, if needed.

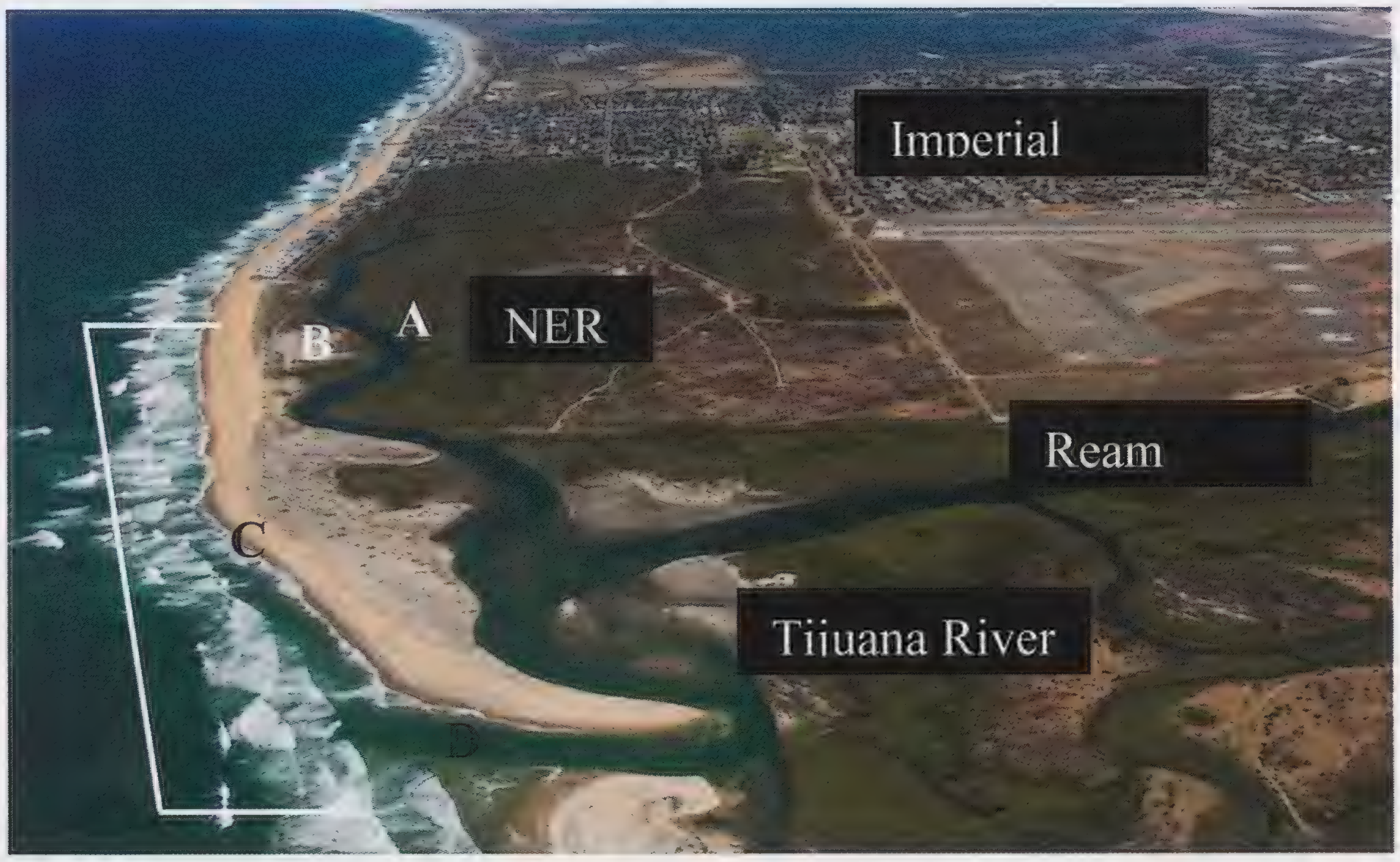

Figure 4. Collection area of Imperial Beach: **A** - Sea Coast Blvd. cul-de-sac; **B** - Beach starting point; **C** - Rocky outcrop about half way to the Tijuana River; **D** - Tijuana River outlet.

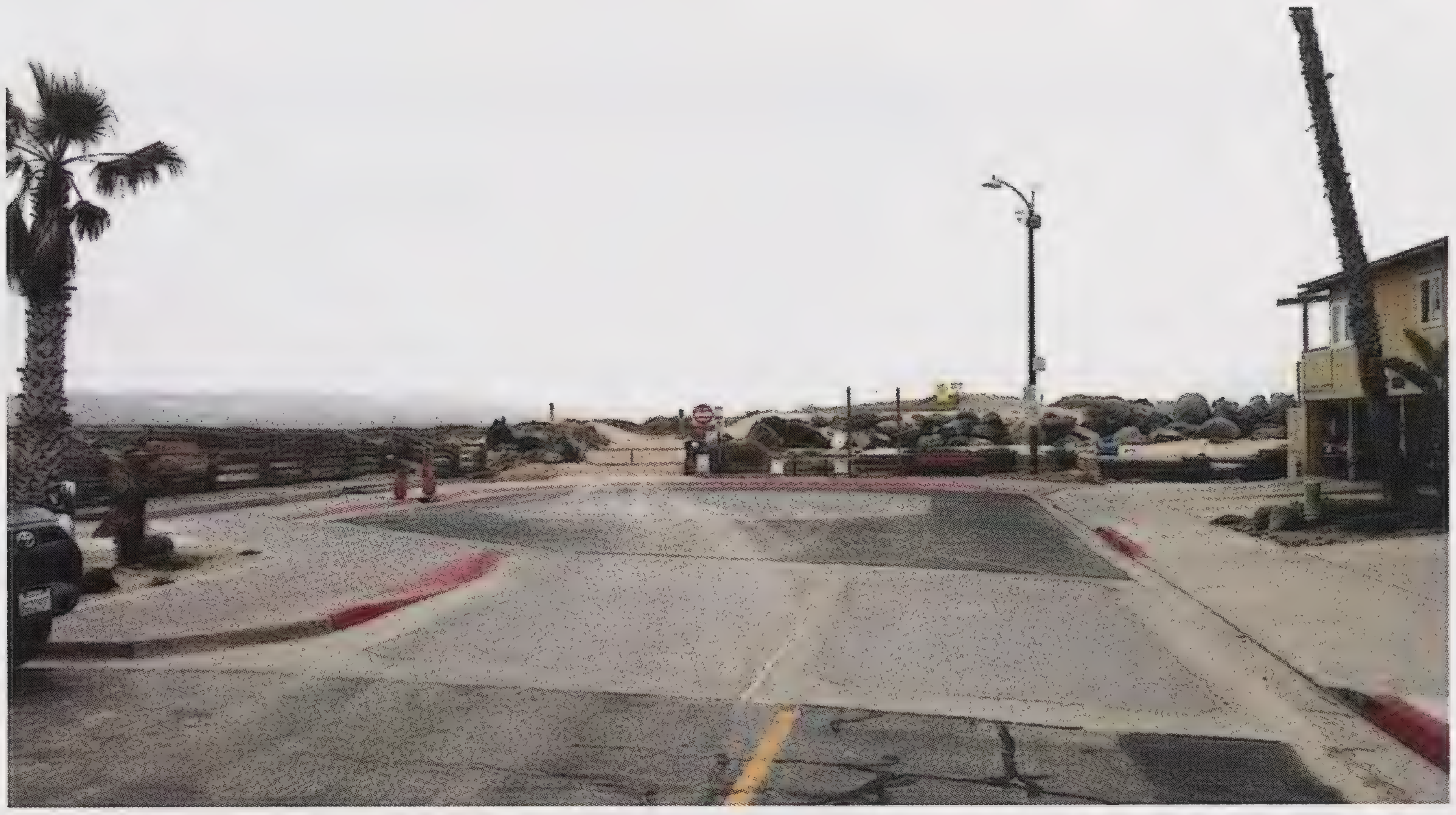

Figure 5. View of Sea Coast Blvd. cul-de-sac looking south, A in Figure 4.

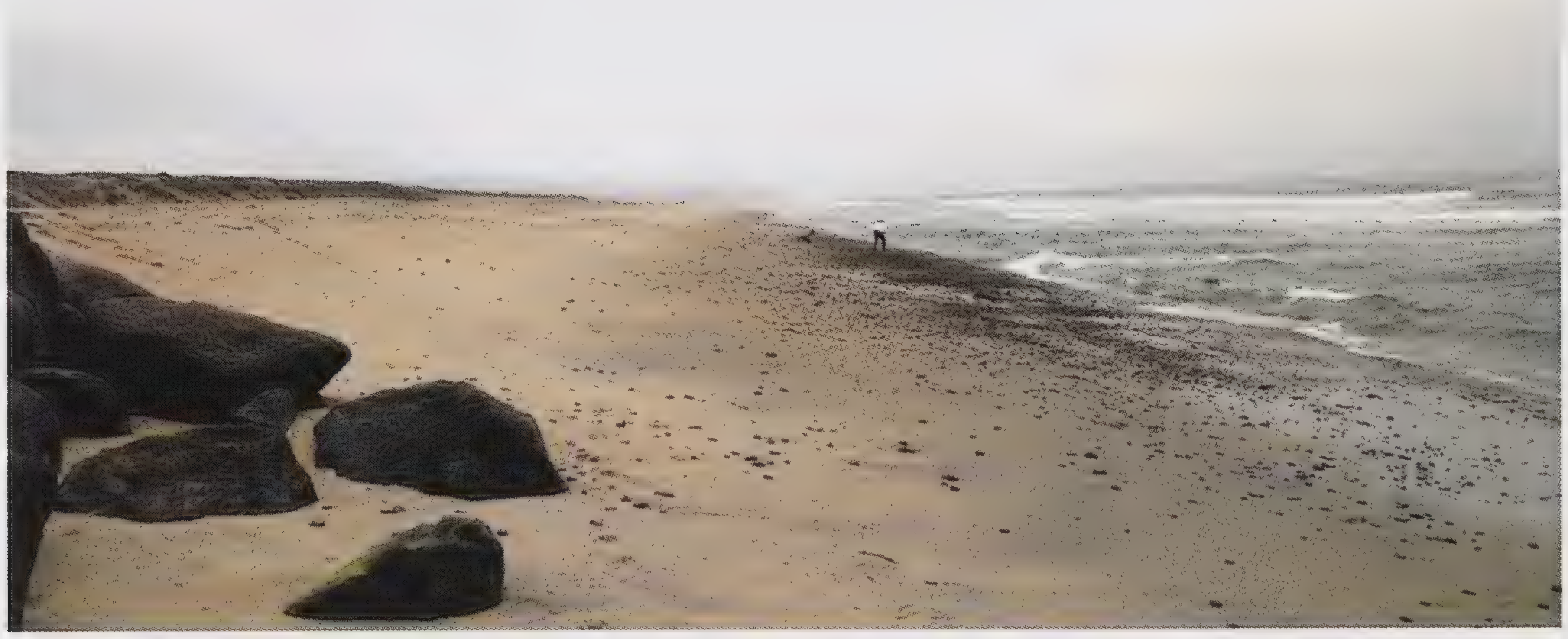

Figure 6. View south on the beach from the Sea Coast Blvd. cul-de-sac, B in Figure 4.

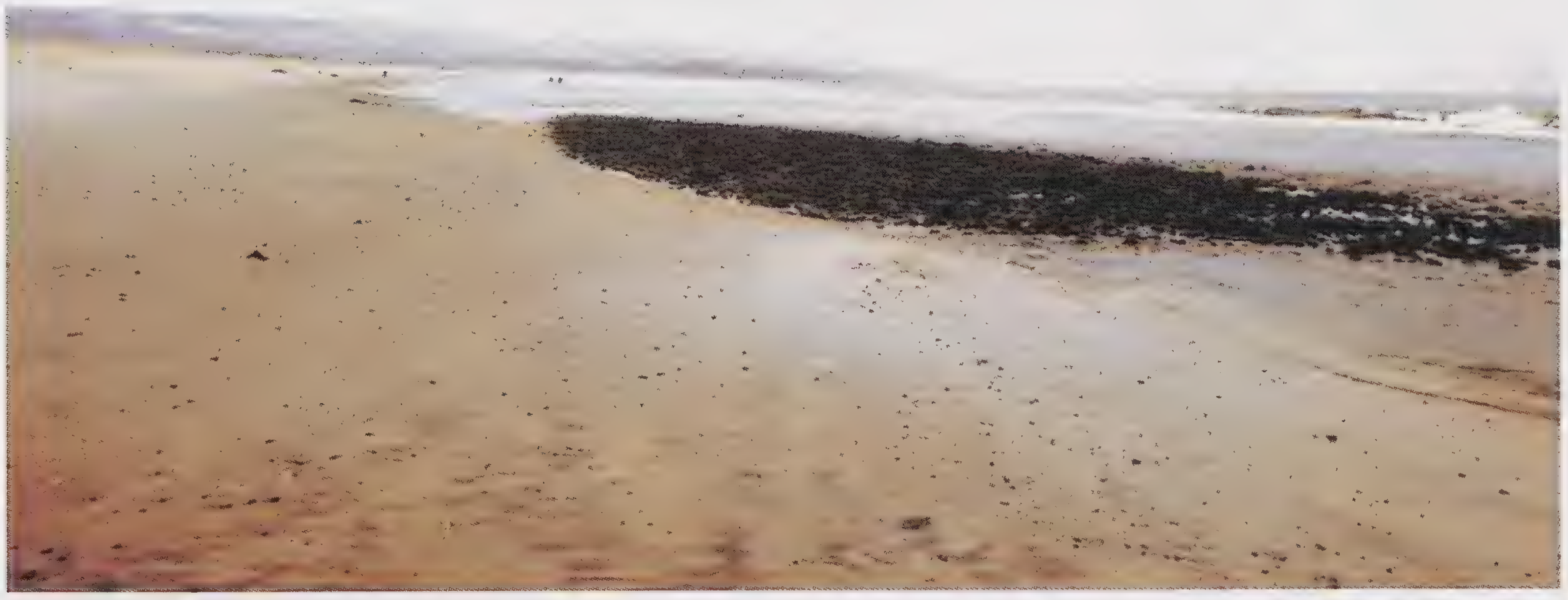

Figure 7. View of the rocky outcrop about one-half mile south from Sea Coast Blvd., C in Figure 4. This area is covered by sand in the summer.

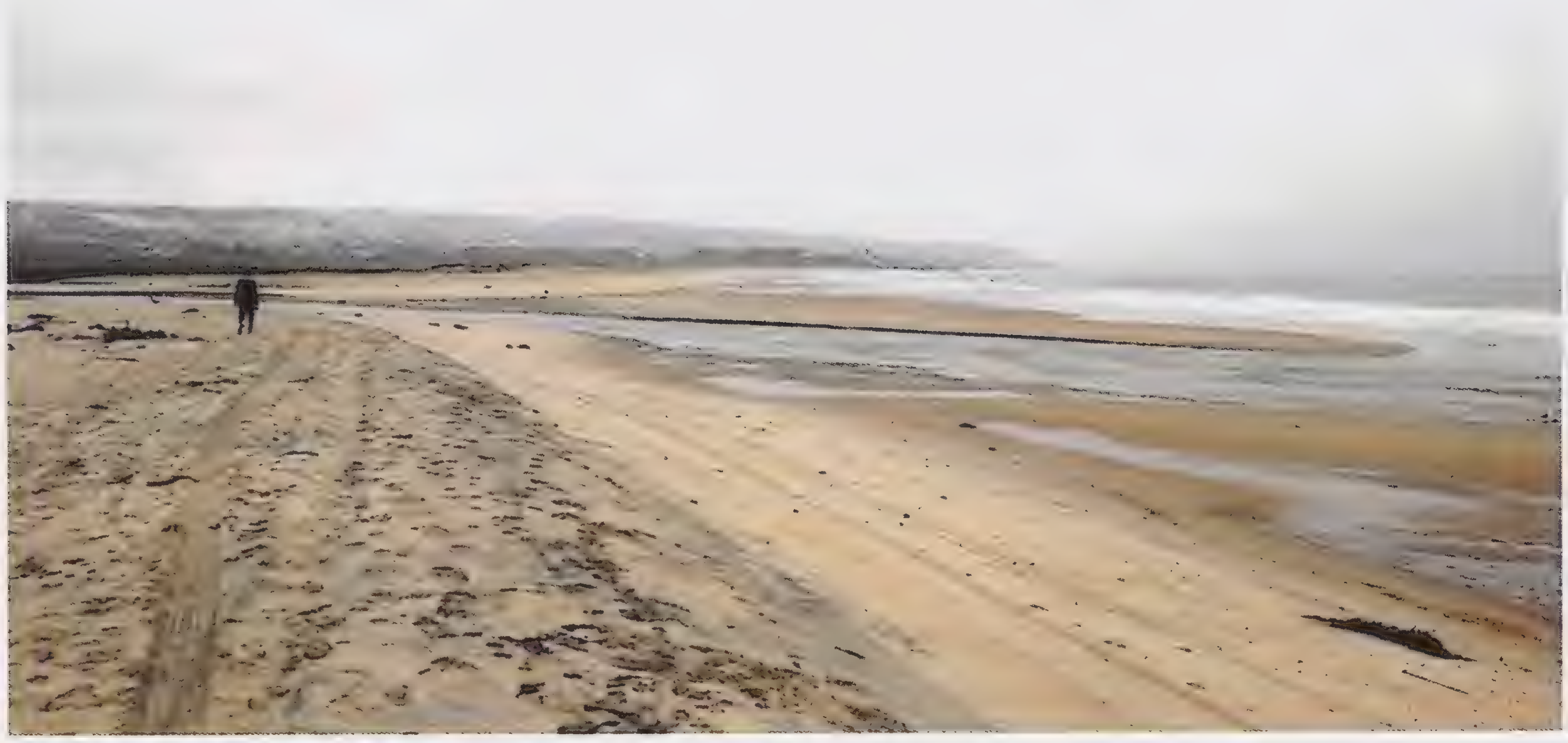

Figure 8. View of the Tijuana River mouth, D in Figure 4.

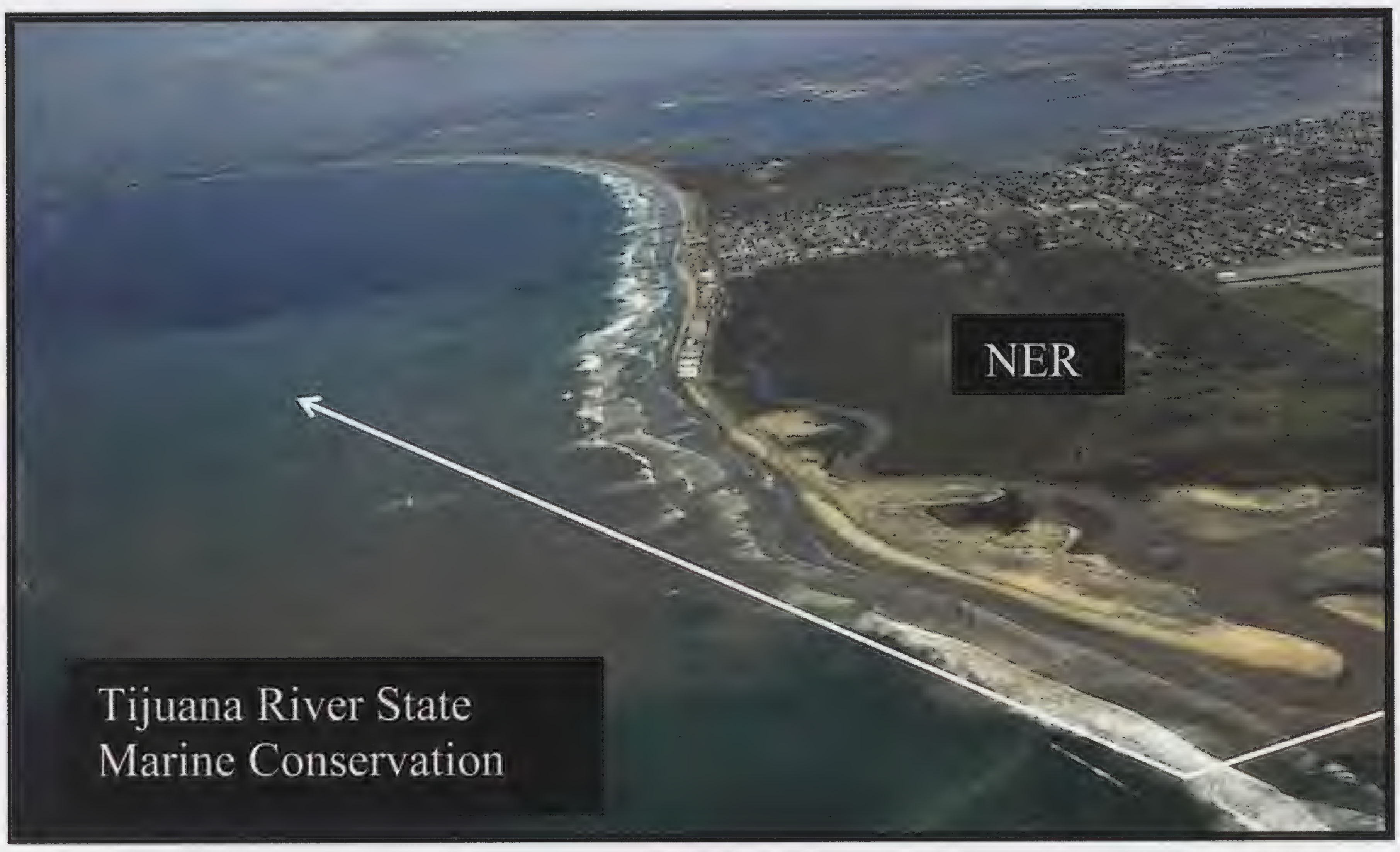

Figure 9. Northern flow from the Tijuana River mouth.

Table 1, below, contains a comprehensive listing of all of the species of shells which I personally collected during this study, and subsequently identified from the area along the coast of Imperial Beach shown in Figure 4.

	Name/Author	Size (mm)	No.*	Prevalence	SSSC page/plate no.
1	***Acmaea mitra*** Rathke, 1833	16.6-28.3	6	U	Page 34, Plate 14 A
2	***Lottia gigantea*** Gray in Sowerby, 1834	43.5	1	R	Page 34, Plate 14 N
3	***Diodora aspera*** (Ratke, 1833)	14.7-34.0	3	U	Page 36, Plate 15 C-D
4	***Fissurella volcano*** Reeve, 1849	15.8-29.5	12	C	Page 36, Plate 15 F-J
5	***Megathura crenatula*** (Sowerby, 1825)	29.8	1	R	Page 36, Plate 15 N-P
6	***Haliotis kamtschatkana*** Jonas, 1845	38.9-95.6	3	R	Page 42, Plate 18 C-D
7	***Tegula aureotincta*** (Forbes, 1850)	18.5-27.7	5	R	Page 46, Plate 20 E
8	***Tegula eiseni*** Jordan, 1936	17.2-17.7	2	R	Page 46, Plate 20 H
9	***Tegula funebralis*** (A. Adams, 1855)	14.0	1	R	Page 46, Plate 20 I
10	***Norrisia norrisii*** (Sowerby, 1838)	35.7	1	R	Page 46, Plate 20 O-P
11	***Megastraea undosa*** (Wood, 1828)	20.2-112.0	3	U	Page 48, Plate 21 A-B
12	***Calliostoma canaliculuatum*** (Lightfoot, 1786)	12.8	1	R	Page 50, Plate 24 D-E
13	***Calliostoma gloriosum*** Dall, 1871	14.8	1	R	Page 50, Plate 24 F-H
14	***Crepidula onyx*** Sowerby, 1824	24.1-52.8	11	C	Page 54, Plate 24 M
15	***Crepipatella lingulat a*** (Gould, 1846)	14.7-21.0	3	U	Page 56, Plate 25 A-C
16	***Crucibulum spinosum*** (Sowerby, 1824)	15.0-25.5	20	C	Page 56, Plate 25 D-E
17	***Vermicularia pellucida eburnean*** (Reeve, 1842)	25.7-43.8	3	U	Page 56, Plate 25 G
18	***Cerithideopsis californica*** (Haldeman, 1840)	14.5-37.7	30	C	Page 56, Plate 25 H-I
19	***Neobernaya spadicea*** (Swainson, 1823)	49.4	1	U	Page 58, Plate 26 A-F
20	***Pusula solandri*** (Gray in Sowerby, 1832)	15.0-15.5	2	R	Page 58, Plate 26 G-I
21	***Neverita reculsiana*** (Deshayes, 1839)	13.7-52.9	11	C	Page 62, Plate 28 F-G
22	***Neverita lewisii*** (Gould, 1847)	101.2	1	R	Page 62, Plate 28 H-J
23	***Crossata californica*** (Hinds, 1843)	80.6-90.4	3	U	Page 64, Plate 29 A-C
24	***Epitonium tinctum*** (Carpenter, 1864)	8.0-14.2	2	R	Page 64, Plate 29 I-K
25	***Kelletia kelletii*** (Forbes, 1850)	46.1-102.2	4	U	Page 64, Plate 29 M
26	***Nassarius tegula*** (Reeve, 1853)	12.5-16.8	3	R	Page 66, Plate 30 I-J
27	***Nassarius fossatus*** (Gould, 1850)	Fragments	3	R	Page 66, Plate 30 M-N
28	***Harfordia chucksnelli*** Callomon & Snyder, 2017	Fragment	1	R	Page 72, Plate 33 G-J
29	***Maxwellia gemma*** (Sowerby, 1879)	Fragment	1	R	Page 86, Plate 35 A-F
30	***Roperia poulsoni*** (Carpenter, 1864)	35.4	1	R	Page 84, Plate 39 I-L
31	***Nucella emarginata*** (Deshayes, 1839)	25.8	1	R	Page 90, Plate 42 A-B
32	***Acanthinucella puntulata*** (Gray in Sowerby, 1835)	20.6	1	R	Page 90, Plate 42 M-P
33	***Olivella biplicata*** (Sowerby, 1825)	14.4-18.4	4	U	Page 100, Plate 47 K-M
34	***Califoniconus californicus*** (Reeve, 1844)	16.0-27.3	4	U	Page 102, Plate 48 M
35	***Bulla gouldiana*** Pilsbry, 1895	48.9	1	U	Page 104, Plate 49 E
36	***Melampus olivaceus*** Carpenter, 1857		25	C	Page 104, Plate 49 J
37	***Modiolus capax*** (Conrad, 1837)	37.2	1	R	Page 106, Plate 50 B
38	***Modiolus rectus*** (Conrad, 1837)	101.3	1	R	Page 106, Plate 50 C
39	***Mytilus californianus*** Conrad, 1837	31.0-109.4	4	C	Page 106, Plate 50 D
40	***Mytilus galloprovincialis*** Lamarck, 1819	27.5-61.2	4	U	Page 106, Plate 50 E
41	***Anadara multicostata*** (Sowerby, 1833)	49.0	1	R	Page 106, Plate 50 G
42	***Crassostraea gigas*** (Thunberg, 1793)	49.7-99.8	11	C	Page 106, Plate 50 I
43	***Ostraea conchaphila*** Carpenter, 1857	28.3-77.7	11	C	Page 106, Plate 50 J
44	***Argopecten ventricosus*** (Sowerby, 1842)	10.0-57.2	34	C	Page 108, Plate 51 D-E Additional images
45	***Leptopecten latiauratus*** (Conrad, 1837)	19.1-26.8	3	U	Page 108, Plate 51 J-L
46	***Crassadoma gigantea*** (Gray, 1825)	56.6-71.6	2	R	Page 108, Plate 51 N-O
47	***Anomia peruviana*** d'Orbigny, 1846	35.1-61.5	9	C	Page 108, Plate 51 Q
48	***Anomia macrochisma*** (Deshayes, 1839)	38.9-69.0	5	U	Page 108, Plate 51 R

49	***Chama arcana*** Bernard, 1976	18.7-32.5	5	U	Page 110, Plate 52 F
50	***Pseudochama exogyra*** (Conrad, 1837)	25.7-56.6	3	U	Page 110, Plate 52 G
51	***Diplodonta orbella*** (Gould, 1851)	9.5-22.2	3	U	Page 110, Plate 52 I
52	***Dallocardia quadragenaria*** (Conrad, 1837)	22.4-74.2	6	U	Page 112, Plate 53 D
53	***Laevicardium elatum*** Sowerby, 1833	13.4-28.4	9	U	Page 112, Plate 53 E
54	***Ctenocardia biangulata*** (Broderip & Sowerby, 1829)	24.8-33.4	2	R	Page 112, Plate 53 G
55	***Donax californica*** Conrad, 1837	13.2-23.6	51	C	Page 112, Plate 53 H
56	***Donax gouldii*** Dall, 1921	21.0-28.7	16	C	Page 112, Plate 53 I
57	***Gari californica*** Conrad, 1837	42.3-95.7	3	R	Page 112, Plate 53 J
58	***Nuttallia nuttallii*** (Conrad, 1837)	22.6-73.6	7	U	Page 112, Plate 53 K
59	***Tagelus californianus*** (Conrad, 1837)	22.5-97.5	8	C	Page 114, Plate 54 A
60	***Tagelus subteres*** (Conrad, 1837)	44.5-78.7	3	C	Page 114, Plate 54 B
61	***Semele decisa*** (Conrad, 1837)	53.5-88.2	4	U	Page 114, Plate 54 C
62	***Leporimetis obesa*** (Deshayes, 1855)	23.0-74.2	6	C	Page 114, Plate 54 D
63	***Macoma nasuta*** (Conrad, 1837)	21.9-49.7	13	C	Page 114, Plate 54 H
64	***Rexithaerus secta*** (Conrad, 1837)	91.9-96.9	3	U	Page 114, Plate 54 I
65	***Aminatis callosa*** (Conrad, 1837)	39.7-88.6	3	R	Page 116, Plate 55 A
66	***Chione californiensis*** (Broderip, 1835)	9.4-56.0	7	U	Page 116, Plate 55 C
67	***Chione undatella*** (Sowerby, 1835)	22.7-48.3	11	C	Page 116, Plate 55 D
68	***Chionista fluctifraga*** (Sowerby, 1853)	47.7	1	R	Page 116, Plate 55 E
69	***Leukoma laciniata*** (Carpenter, 1864)	41.2-78.6	6	C	Page 116, Plate 55 H
70	***Leukoma staminea*** (Conrad, 1837)	24.5-51.8	15	C	Page 116, Plate 55 I
71	***Ruditapes philippinarum*** (Adams & Reeve, 1850)	43.3-56.7	3	U	Page 116, Plate 55 J
72	***Saxidomas nuttalli*** (Conrad, 1837)	67.3-98.5	3	U	Page 116, Plate 55 K
73	***Tresus nuttallii*** (Conrad, 1837)	52.5-149.4	4	U	Page 118, Plate 56 B
74	***Mactrotoma californica*** (Conrad, 1837)	33.3	1	R	Page 118, Plate 56 D
75	***Platyodon cancellatus*** (Conrad, 1837)	53.8-91.6	4	U	Page 118, Plate 56 E
76	***Zirfacea pilbryi*** Lowe, 1931	47.8-48.4	2	R	Page 118, Plate 56 G
77	***Dentalium vallicolens*** Raymond, 1904	14.2-21.6	3	R	Page 120, Plate 57 D
78	***Dentalium neohexagonum*** Pilsbry & Sharp, 1897	15.5-24.0	3	R	Page 120, Plate 57 E
79	***Terebratalia transversa*** Sowerby, 1846	15.2-25.1	2	R	New
80	***Tegillarca granosa*** (Linnaeus, 1758)	24.0	1	R	New
81	***Tellina bodegensis*** Hinds, 1845	33.9-43.5	7	U	New
82	***Semele rubropicta*** (Dall, 1871)	38.8	1	R	New
83	***Epilucina californica*** (Conrad, 1837)	29.0	1	R	New
84	***Glycymeris septentrionalis*** (Middendorff, 1849)	19.7-20.3	2	R	New
85	***Spisula catilliformis*** (Carpenter, 1867)	110.7-111.8	2	R	New
86	***Terebra hemphilli*** (Vanatta, 1924)	24.6	1	R	New
87	***Solen rosaceus*** Carpenter, 1864	30.0-35.0	2	R	New
88	***Megastraea undosa*** operculum (Wood, 1828)	48.2	1	R	New
89	***Epitonium hindsii*** (Carpenter, 1856)	19.3	1	R	New
90	***Trachycardium panamense*** (Sowerby, 1833)	47.7-62.3	2	R	New
91	***Corbicula fluminea*** (Muller, 1774)	25.1	1	R	New
92	***Anomia peruviana*** d'Orbigny, 1846	35.1-40.1	2	C	Additional images
93	***Leukoma steminea*** (Conrad 1837)	31.3-38.5	4	C	Additional image

***Represents the number of specimens collected, not the number observed on the beach.**

Table 1. Listing of shells collected and identified from the end of Seacoast Blvd. to the Tijuana River in Imperial Beach. Based upon my experience during this study I rated the relative abundance of each species as: C = Common, U = Uncommon, and R = Rare.

Identification of these shells would have been difficult without an easy to use reference guide. The idea of publishing a book on the seashells of California was first considered by the San Diego Shell Club in 2016 with the hopes of selling it at the 2018 COA conference in San Diego. David Berschauer and Roger Clark furthered this idea by suggesting an identification book that could be used by seasoned collectors and amateurs alike to identify shells found on the beaches of southern California and to diveable depths. At that time the most recent book on the shells of this region was written by Dr. James McLean and published by the Los Angeles Museum of Natural History in 1969. Unfortunately, this book was published in black and white, and in a small format, which made identification of the shells difficult. The new book would provide updated taxonomy and full color images of each species. However, because of the vast number of marine mollusks (>2,000 species in the region) the scope of the book had to be limited to make it affordable and to ensure it could be completed before the 2018 COA conference. This included defining the biogeographical region covered by the book, focusing on shells that could be reasonably found, and avoiding shells that may not necessarily be observed by beachcombers because of their substantially smaller size; also known as micro-shells. Consequently, the book focused on the Californian Marine Molluscan Province extending from Point Conception, California, United States, southwards to Punta Eugenia, Baja California Sur, Mexico. In addition, most shells that do not often appear on the beach because of the great depth at which they are found or their distance from shore, were not included. Consequently, species were listed that are primarily found from the intertidal zone to depths accessible by SCUBA diving. Finally, shells having an average size of 7 mm or less were not included. Even with these limitations, the book contains over 345 species of mollusks, including: 65 species of chitons; 198 species of marine gastropods; 1 species of cephalopod; 76 species of marine bivalves; and 5 species of scaphopods. All of these species are presented in full page color plates to help the reader identify their shells more easily. To date, this book is one of the most popular publications produced and sold by the San Diego Shell Club. I highly recommend owning a copy of this book if you collect shells either on the beach or by SCUBA diving.

After writing this article, I was pleased to find that most of the shells I was able to find in Imperial Beach were listed in SSSC. The few that were not identified in the book are shown in the accompanying SSSC supplemental insert. In addition, I have included other representative images of shells presented in the book that are extremely variable in color and or shape as well as an image of the operculum of *Megastraea undosa,* which is found frequently on the beach. With these new additions, the total number of molluscan species is now 353 including: 65 species of chitons, 199 species of marine gastropods, 1 species of cephalopod, 1 species of brachiopod, 83 species of marine bivalves, and 5 species of scaphopods. It is my hope that the authors in conjunction with the San Diego Shell Club continue to produce and update this book for future collectors.

Enclosed with this journal are two full page color inserts which I prepared (containing new species additions) as a supplement to the book Seashells of Southern California - Marine Shells of the Californian Province, D. Berschauer and R. Clark, 2018.

Epilogue: As with most shell collecting from the beach, there were a few shells which I was not able to identify (Figure 10). If you know the identity of any of these shells, please send me an email with your thoughts to: dwaller@dbwipmg.com.

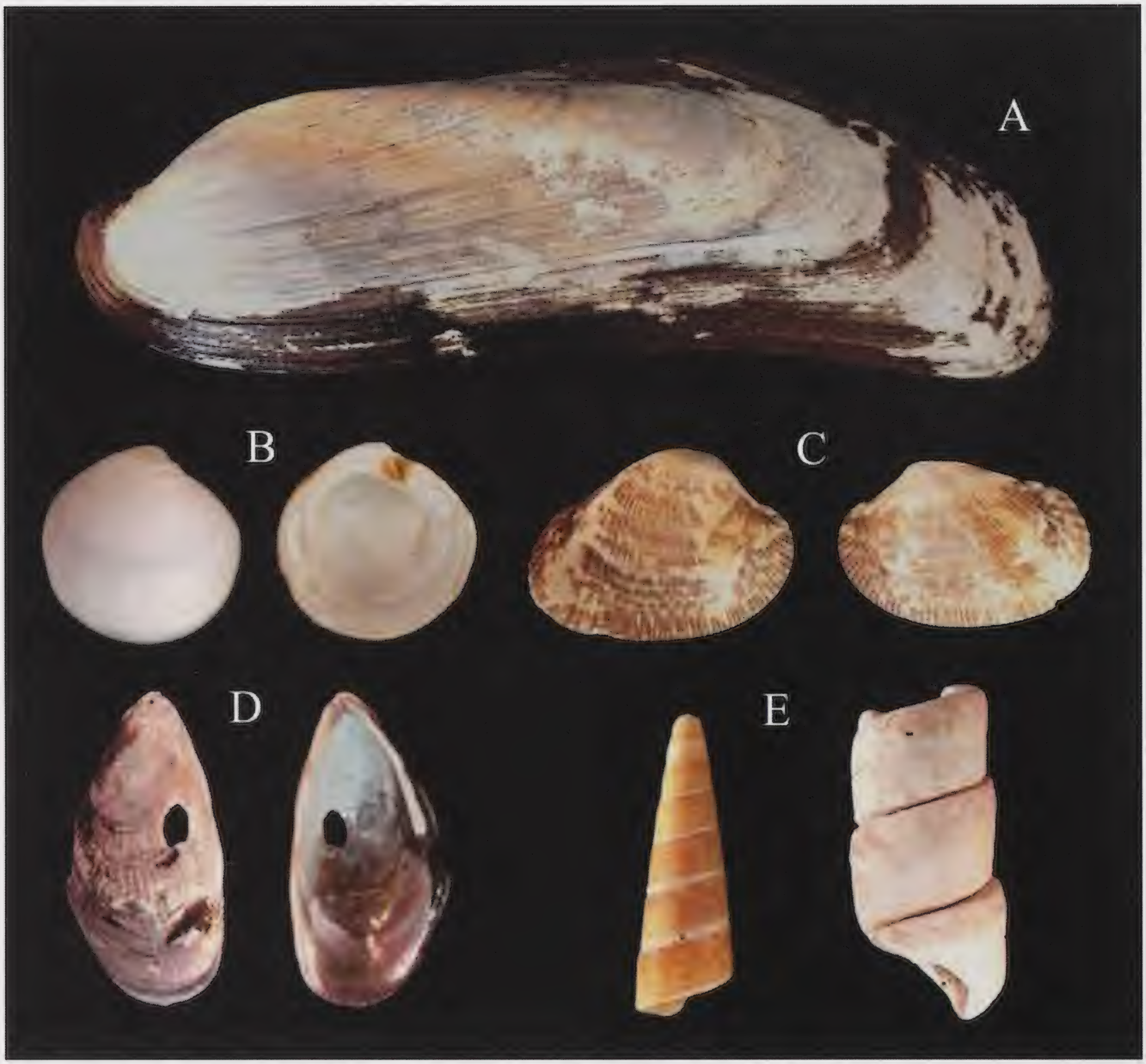

Figure 10. Please help me identify the shells in the images above. **A** - A large shell about 6.5 inches listed as *Volsella flabellata* (Gould, 1850) in Fish Bulletin No. 90, Common Marine Bivalves of California J. E. Fitch 1953, however, no further information is available on this shell; **B** - A small shell about 0.5 inches very heavy about 1/8 inch thick similar in shape to *Diplodonta*; **C** - Coloration similar to *Leukoma steminea* (Conrad, 1837), however, the shape is more similar to *Acar bailyi* Bartch, 1931 but about 1.5 inches; **D** - Similar to *Mytilus californianus* Conrad, 1837 but has longitudinal ridges like *Septfer bifurcatus* (Conrad, 1837), **E** - Unknown *Terebra*-like shell very smooth surface each about 1.5 inches.

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San Diego County Fair

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Hats off to the San Diego Shell Club on their 5th year entry at Del Mar Fair, San Diego. Located in the Gym and Mineral building, our Club's exhibits included Wes Farmer's amazing nudibranch sculptures, along with presentations from Paul Tuskes, David Berschauer, Leo Kempczenski, and Lisa Lindahl.

A special thanks to Dewitt Rathbun for his diligence as our main docent; he was there almost every day to great the public with a warm smile, sharing his passion for shell collecting and general knowledge of the world of Conchology. Get that guy a new t-shirt! (Dewitt explained that when not talking to people he was reading people's t-shirts).

The large center cube display had some new coral pieces generously donated by Marty Beals, of Tideline, Inc., Inglewood, California. Thank you Marty!

We received many compliments and infected several folks with the shell "bug", new friends were added to our Club's roster, don't we all enjoy hearing people say, "I had no idea shells were so beautiful" when we explain our hobby? Until next year; happy shelling from San Diego Shell Club.

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E. adansonianus adansonianus (Crosse & Fischer, 1861),Bahamas, 106.1 mm. *B. poppei* (Anseeuw, 2003), Tonga Islands, 58.8 mm. *P. amabilis* f. *maureri* Harasewych & Askew, 1993, USA, 42 mm. *B. tangaroana* (Bouchet & Métivier, 1982), New Zealand, 55.9 mm. *P. quoyanus* (Fischer & Bernardi, 1856), Curaçao, 50.7 mm. *B. philpoppei* Poppe, Anseeuw & Goto, 2006, Philippines, 65.1 mm. *B. charlestonensis* Askew, 1987, Martinique, 77.3 mm. *B. midas* (Bayer, 1965), Bahamas, 82.7 mm.

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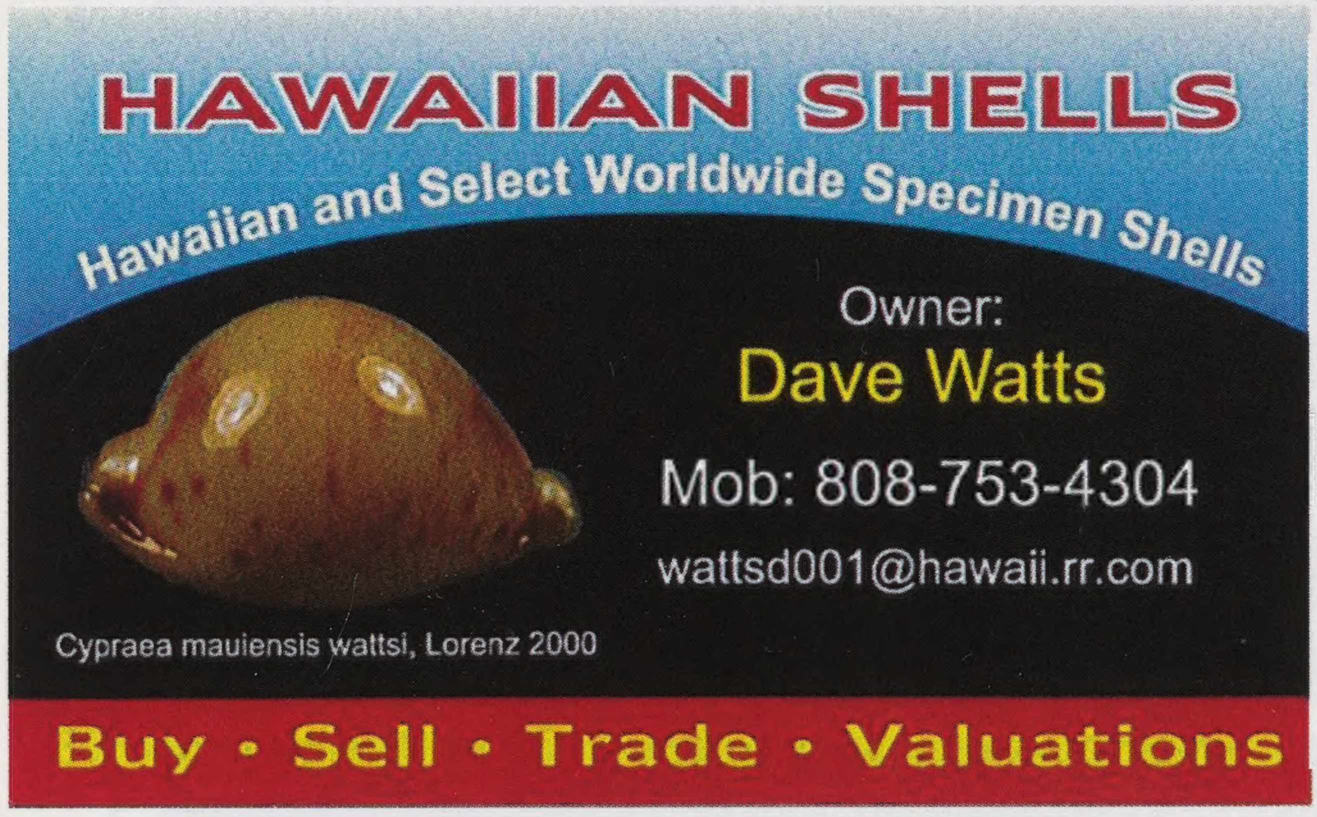
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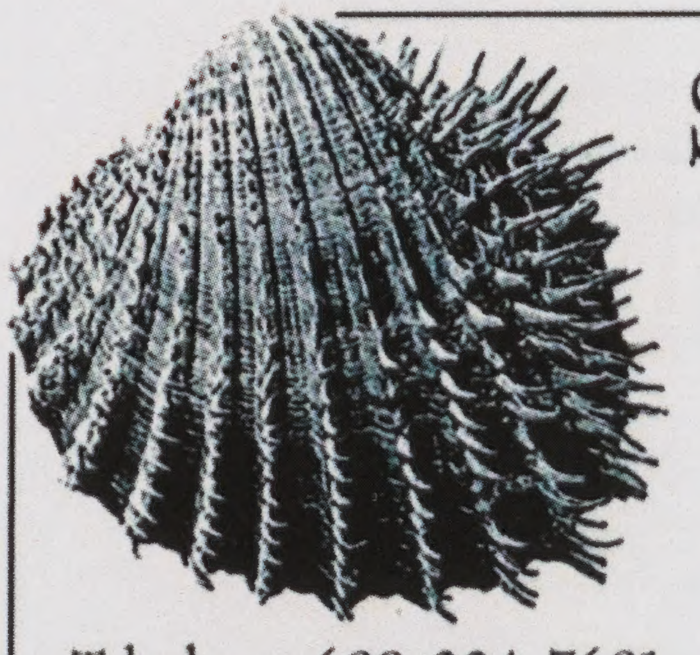
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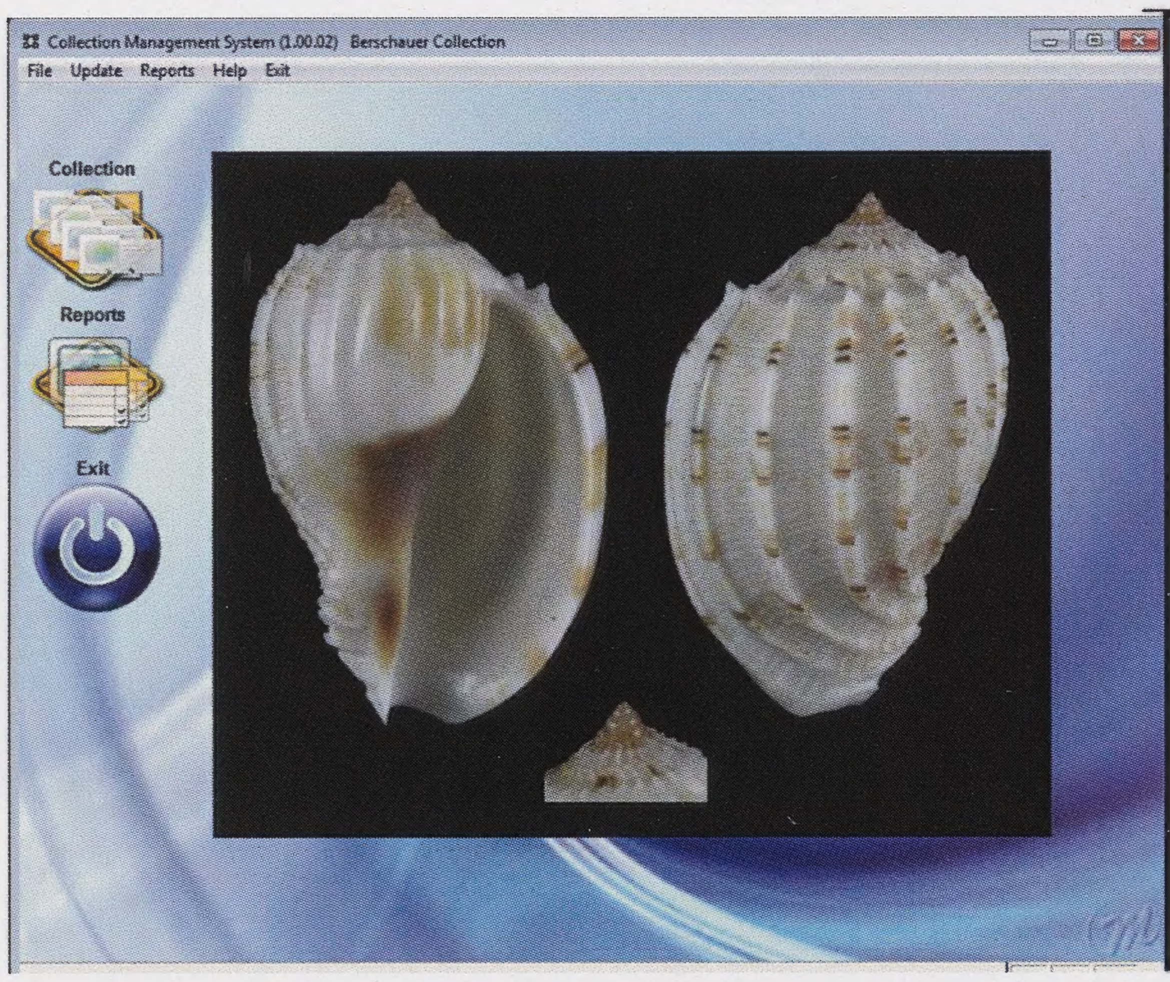
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Back cover: Holotypes of the *Voluta polypleura - demarcoi* complex from the coast of Honduras (Cover artistic credit: Rex Stilwill).

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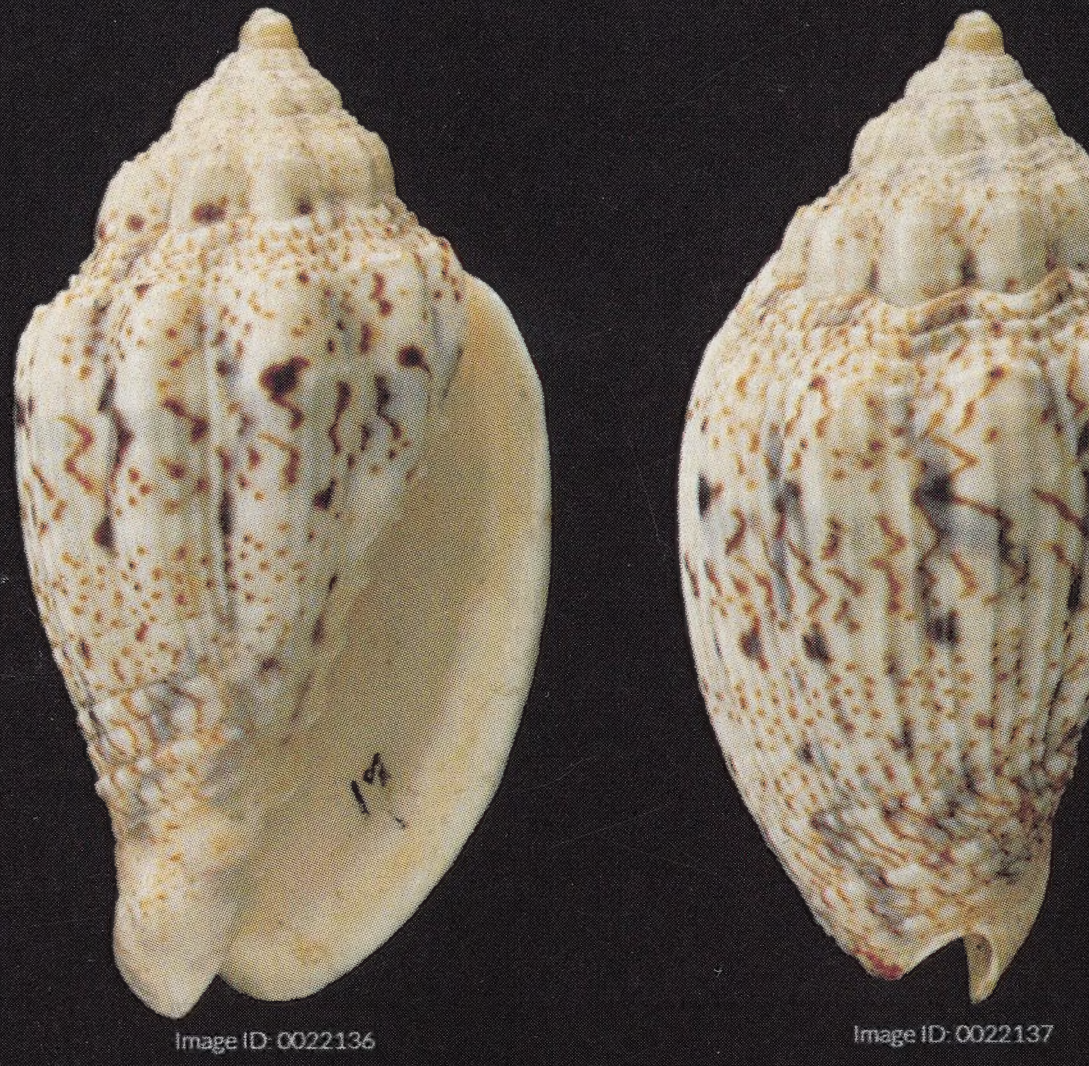

Voluta musica var. polypleura Crosse, 1876 | LIVCM.2.4.1885.17 [124]

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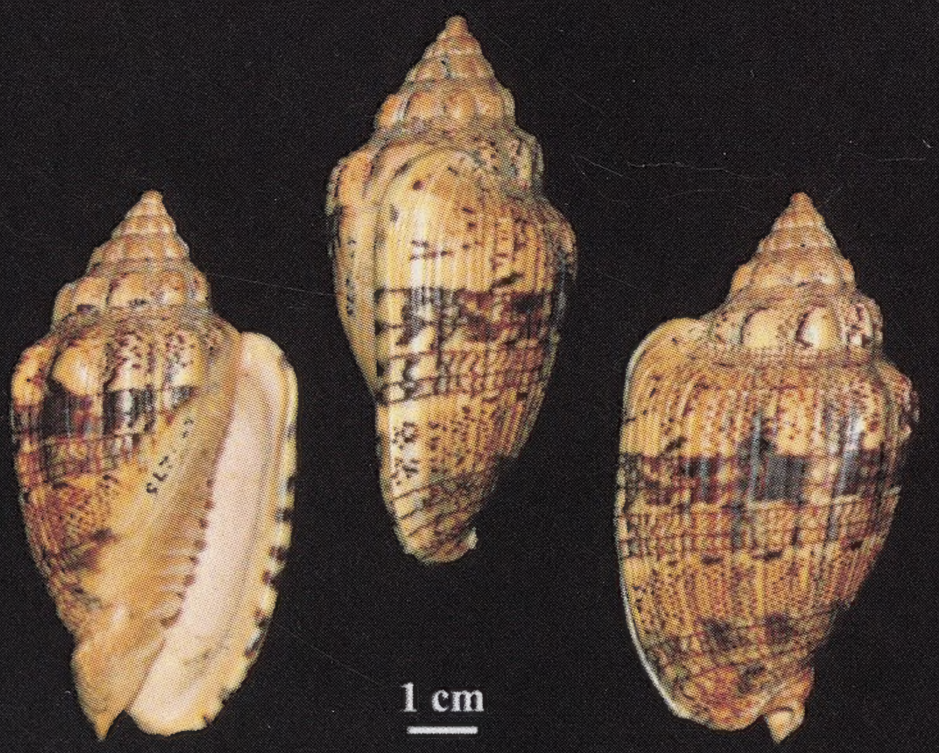
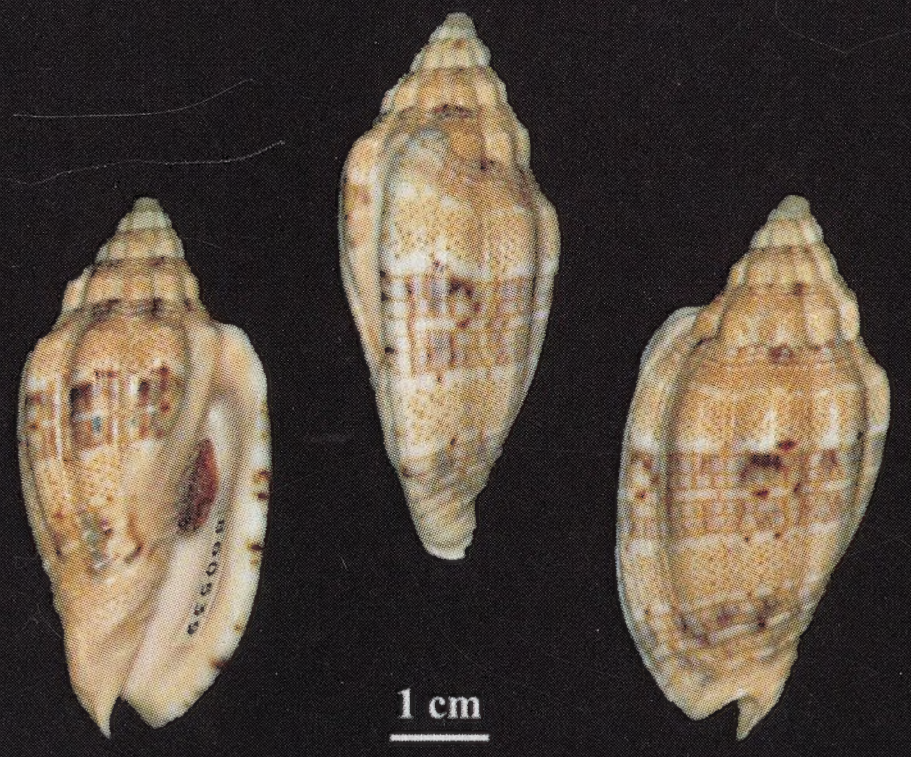
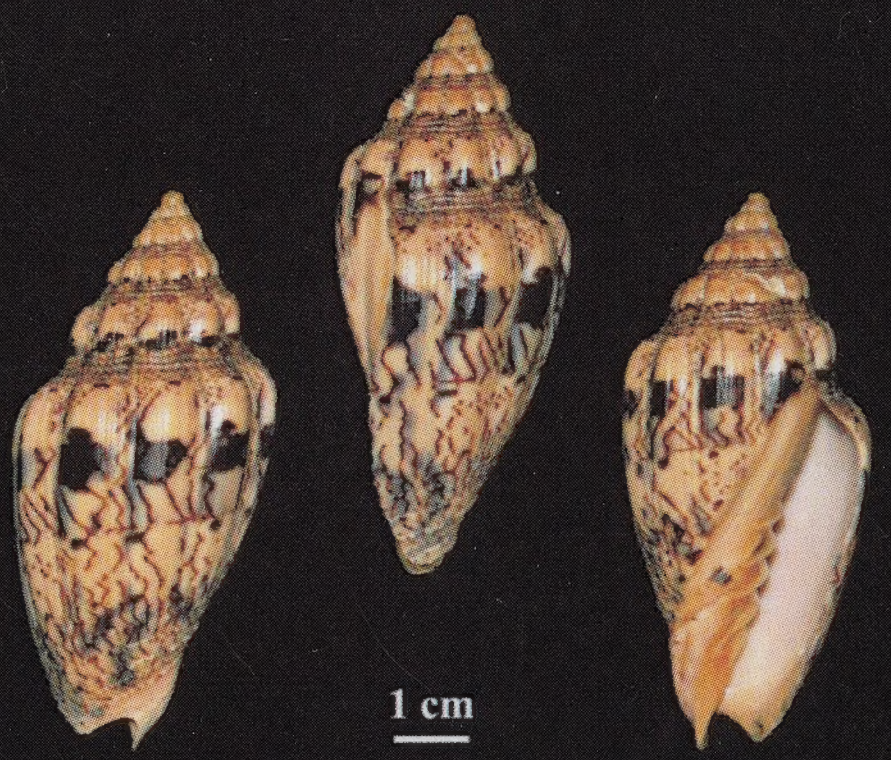


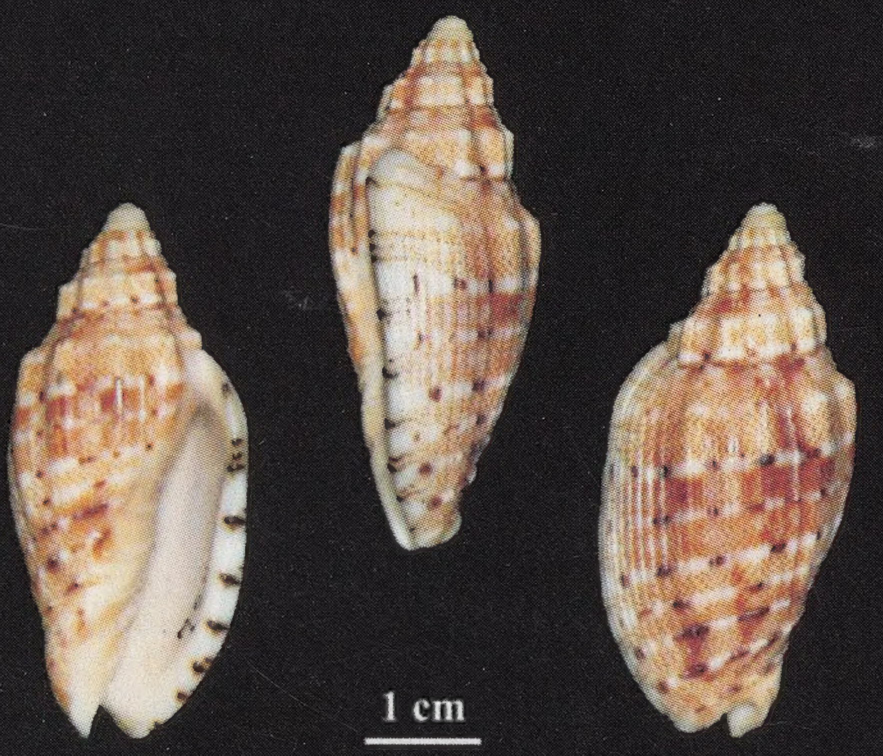
Voluta dermarcoi Olsson, 1965
Holotype USNM 637275



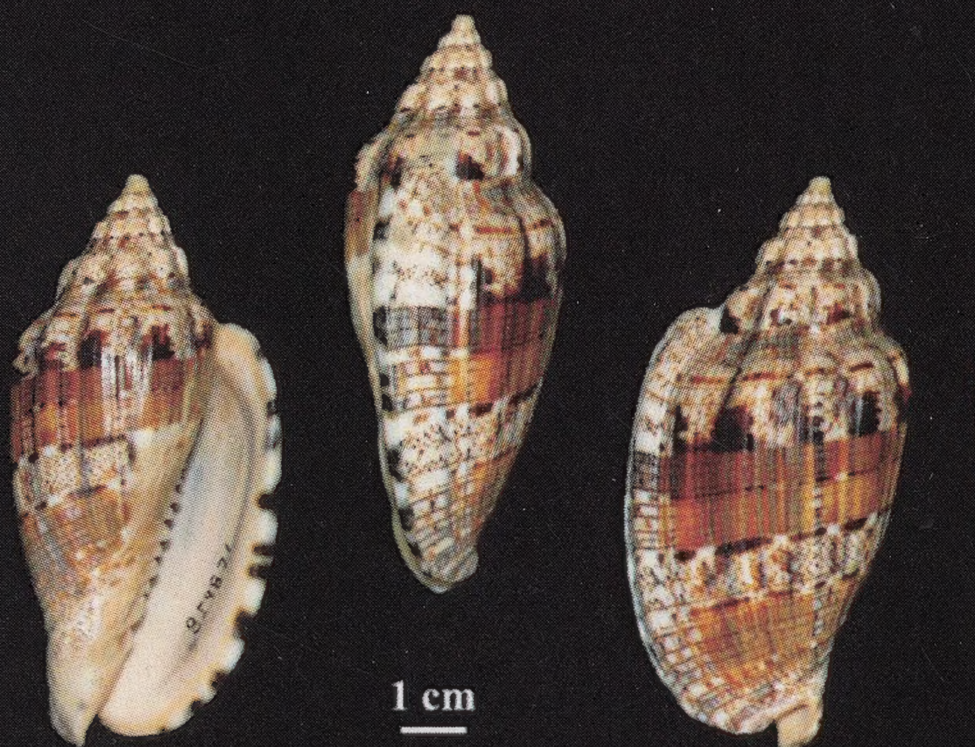
Falsilyria ernesti Petuch, 1990
Holotype USNM 860539



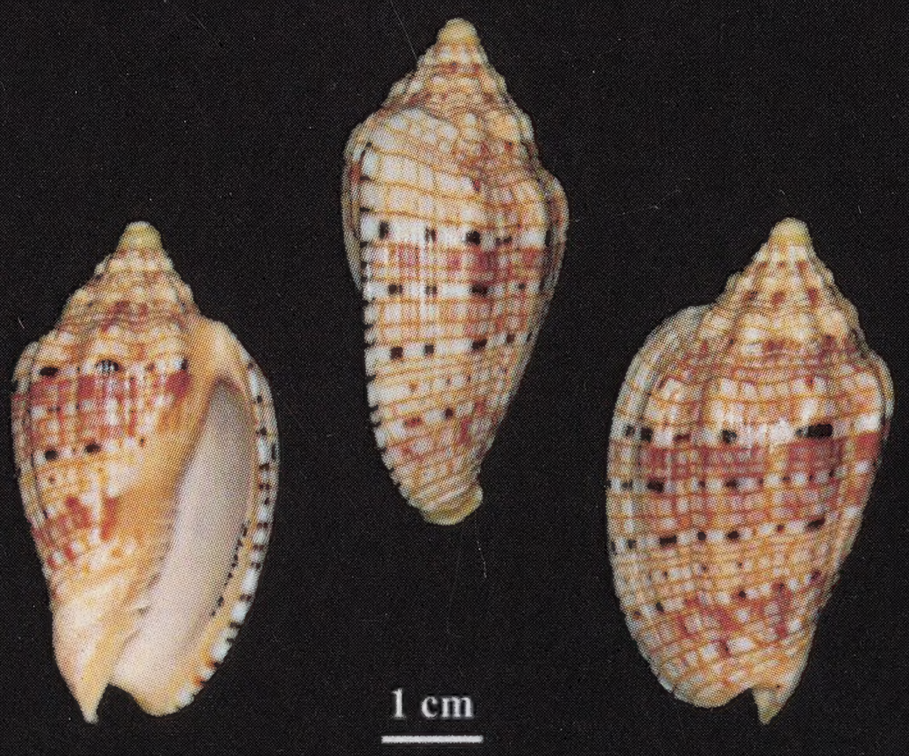
Falsilyria garciai Petuch, 1981
Holotype USNM 784641



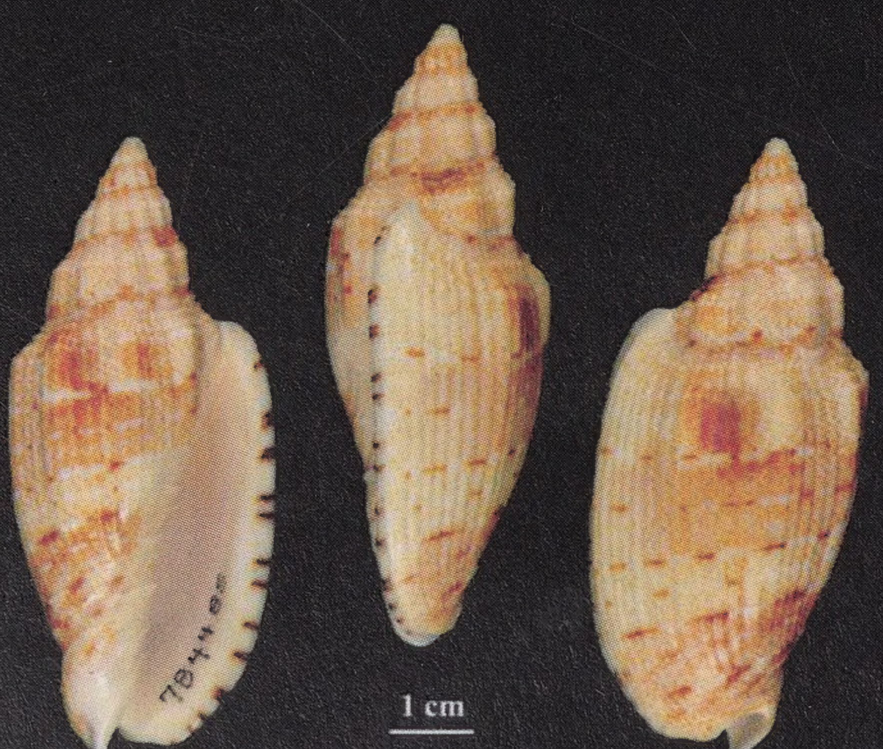
Falsilyria harasewychi Petuch, 1987
Holotype USNM 784486



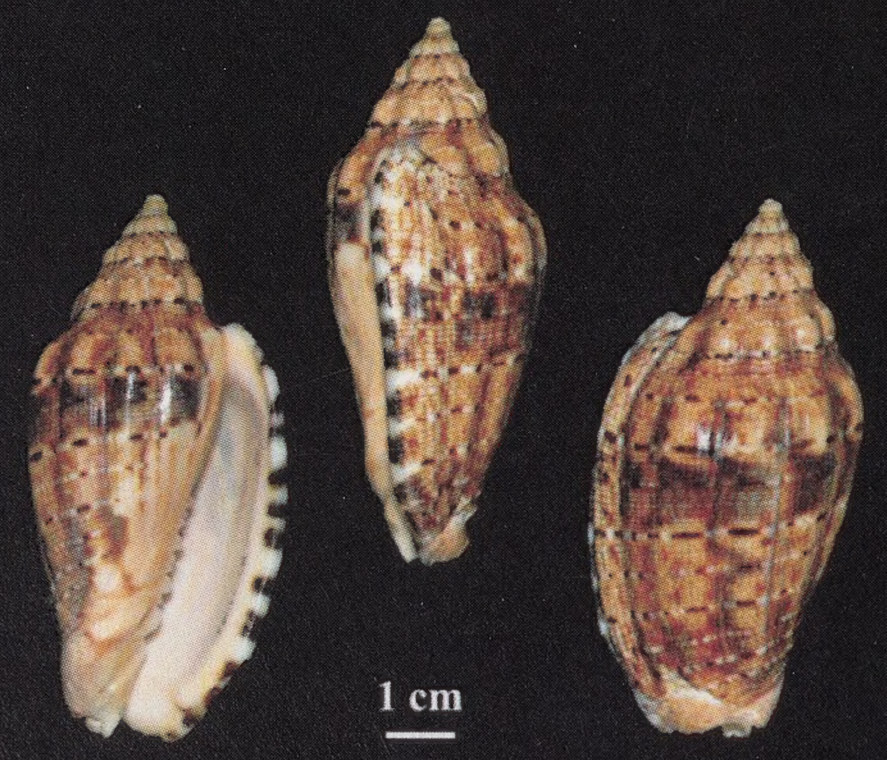
Falsilyria hilli Petuch, 1987
Holotype USNM 859871



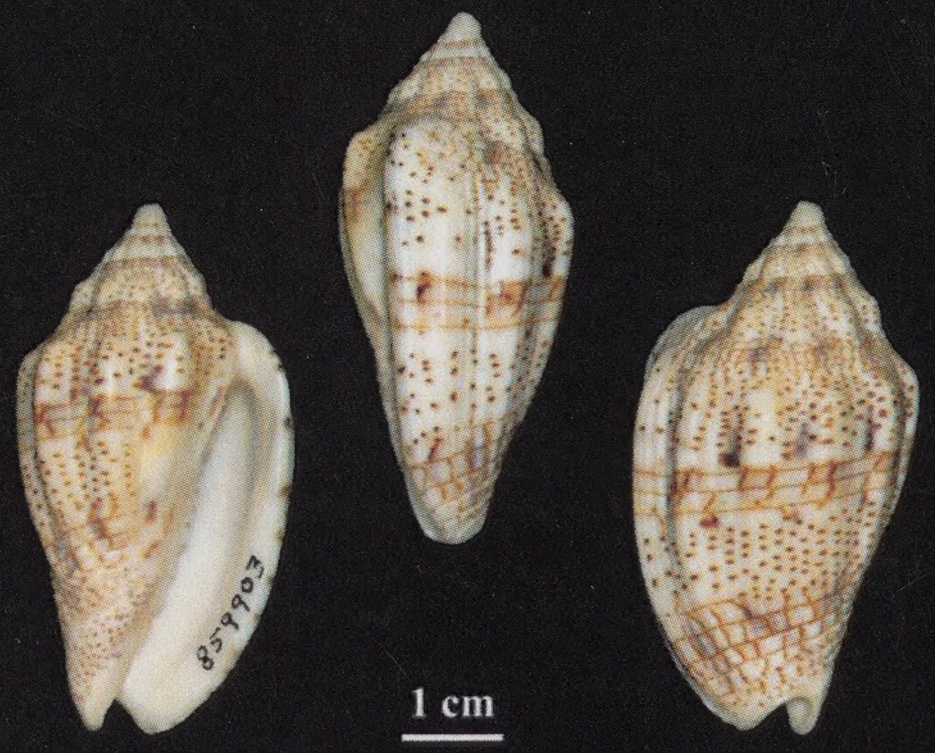
Falsilyria kotorai Petuch, 1981
Holotype USNM 784642



Falsilyria morrisoni Petuch, 1981
Holotype USNM 784485



Falsilyria retemirabilis Petuch, 1981
Holotype USNM 784643



Falisyria sunderlandi Petuch, 1987
Holotype USNM 859903